

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE. Assistant Editor: H. H. KIMBALL.

VOL. XXXI.

FEBRUARY, 1903.

No. 2

INTRODUCTION.

The MONTHLY WEATHER REVIEW for February, 1903, is based on data from about 3300 stations, classified as follows:

Weather Bureau stations, regular, telegraph and mail, 160; West Indian service, cable and mail, 8; River and Flood service, rainfall only, 49, river and rainfall, 162; voluntary observers, domestic and foreign, 2565; total Weather Bureau Service, 2944; Canadian Meteorological Service, by telegraph and mail, 20, by mail only, 13; Meteorological Service of the Azores, by cable, 2; Meteorological Office, London, by cable, 8; Mexican Telegraph Company, by cable, 3; Army Post Hospital reports, 18; United States Life-Saving Service, 9; Southern Pacific Company, 96; Hawaiian Meteorological Service, 75; Jamaica Weather Service, 130; Costa Rican Meteorological Service, 25; The New Panama Canal Company, 5; Central Meteorological Observatory of Mexico, 20 station summaries and printed daily bulletins and charts, based on simultaneous observations at about 40 stations; Mexican Federal Telegraph Service, printed daily charts, based on about 30 stations.

Special acknowledgment is made of the hearty cooperation of Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Mr. Curtis J. Lyons, Territorial Meteorologist, Honolulu, H. I.; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt. S. I. Kimball, Superintendent of the United States Life-Saving Service; Lieut. Commander W. H. H. Southerland, Hydrographer, United States Navy; H. Pittier, Director of the Physico-Geographic Institute, San José,

Costa Rica; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. M. Shaw, Esq., Secretary, Meteorological Office, London; Rev. Josef Algué, S. J., Director, Philippine Weather Service; and H. H. Cousins, Chemist, in charge of the Jamaica Weather Office.

Attention is called to the fact that the clocks and self-registers at regular Weather Bureau stations are all set to seventy-fifth meridian or eastern standard time, which is exactly five hours behind Greenwich time; as far as practicable, only this standard of time is used in the text of the REVIEW, since all Weather Bureau observations are required to be taken and recorded by it. The standards used by the public in the United States and Canada and by the voluntary observers are believed to conform generally to the modern international system of standard meridians, one hour apart, beginning with Greenwich. The Hawaiian standard meridian is $157^{\circ} 30'$, or $10^{\text{h}} 30^{\text{m}}$ west of Greenwich. The Costa Rican standard of time is that of San José, $0^{\text{h}} 36^{\text{m}} 13^{\text{s}}$ slower than seventy-fifth meridian time, corresponding to $5^{\text{h}} 36^{\text{m}}$ west of Greenwich. Records of miscellaneous phenomena that are reported occasionally in other standards of time by voluntary observers or newspaper correspondents are sometimes corrected to agree with the eastern standard; otherwise, the local standard is mentioned.

Barometric pressures, whether "station pressures" or "sea-level pressures," are now reduced to standard gravity, so that they express pressure in a standard system of absolute measures.

FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

From February 1 to 17 there was a succession of barometric disturbances of marked intensity over the southern and eastern districts of the United States. These disturbances, four in number, apparently originated over the southern Plateau region at intervals of about four days. From the southern Plateau they moved eastward to Texas, and thence northeastward to the Atlantic coast attended, in three instances, by secondary storms that apparently developed over the west part of the Gulf of Mexico. During this period but one disturbance of marked strength advanced from the Northwest. On the morning of the 9th this disturbance appeared, with barometric pressure below 29.30 inches, in the region north of Washington and western Montana. By the morning of the 10th the northwestern storm, and another from the southern Plateau, had advanced to the one-hundredth meridian. During the 10th the tracks of these storms converged, and by the morning of the 11th they had united over Lake Michigan.

The storms of this period, 1st to 17th, were attended by heavy rain in the southern and heavy snow in the northern districts east of the Pacific coast States, and by high winds on the Atlantic and Gulf coasts and the Great Lakes, and their passage was followed by cold waves of marked severity. In the Ohio Valley and the Southern States the excessive precipitation resulted in high water stages in the rivers and streams.

From the 17th to 24th there was a period of stagnated

weather conditions generally over the United States. From the 23d to the 28th a storm moved from Arizona to the St. Lawrence Valley, its passage over the Great Lakes being attended during the 27th and 28th by storms of marked severity.

Three of the storms referred to, of the first and second decades of the month, and a storm that occupied Newfoundland on the 1st, apparently moved north of east from the American coast and passed to the north of the British Isles, attended over the Atlantic by gales of unusual violence.

A notable feature of the weather of the month was that while the rapid succession of severe storms continued over the United States, the Atlantic, and northern Europe the barometric pressure continued abnormally high over southern, and more especially southwestern Europe; from the 23d, when the center of the last American storm of the month reached the region north of Scotland, until the 28th, barometric pressures were low over southwestern Europe and the center of a barometric depression of exceptional strength remained almost stationary north of the British Isles. The steep barometric gradient of this apparently stationary disturbance extended over the Atlantic almost to the American coast, and caused, during the last five or six days of the month, a continuation of violent gales from Newfoundland to the western European coasts.

The first important storm of the month occupied Nevada on

the morning of the 1st, and reached the Gulf of St. Lawrence on the 5th. The heavy rains of the 3d, 4th, and 5th, accompanied by thawing, resulted in floods in the Allegheny and Monongahela rivers and tributaries. All interests about the headwaters of the Ohio likely to be affected by high water were kept informed by day and night of the stage of the rivers, and advices and warnings were issued hourly by the Pittsburgh office of the Weather Bureau with regard to anticipated stages. On the 4th that office advised the public to prepare for high water, and predicted a stage of 24 feet on the gage at Pittsburgh by the 5th. A stage of 24 feet was reached at noon on the 5th. On the morning of the 5th when the western storm referred to was central over the Canadian Maritime Provinces, the following message was cabled to Lloyds, London:

Severe storm will move eastward from Newfoundland to-day.

This storm reached a position north of the British Isles on the 10th, and by the morning of the 11th had passed over the northern portion of the Scandinavian Peninsula, with central barometric pressure about 28.40 inches.

The second storm of the month appeared on the 6th over New Mexico, to which position it probably advanced from the extreme southern California coast. Moving rapidly eastward this disturbance reached the middle Gulf coast on the morning of the 7th, passed northeastward to Lake Erie by the morning of the 8th, and reached Nova Scotia by the morning of the 9th, with rapidly increasing strength. On the morning of the 7th the following message was telegraphed from Washington to Weather Bureau stations in northern Ohio, western and northern Pennsylvania, and New York:

Heavy snow indicated for to-night in northern Ohio, western Pennsylvania, western and northern New York.

Warning of heavy snow in northern Illinois and northern Indiana was sent from the Weather Bureau office at Chicago.

The snowfall of the 8th was particularly heavy in the central districts of New York, where railroad trains were delayed.

On the morning of the 9th two barometric disturbances appeared, one over New Mexico and the other over the British Northwest Territory. By the morning of the 11th these storms had united over Lake Michigan with a secondary disturbance that appeared on the Texas coast on the morning of the 10th. Moving rapidly eastward the center of disturbance reached the Canadian Maritime Provinces on the 12th, with barometric pressure about 29.00 inches, passed north of the British Isles during the 19th, and reached the extreme northern coast of Norway on the 20th, with central barometric pressure about 28.80 inches.

The severest storm of the month appeared over the southern Plateau on the 12th, and remained nearly stationary over that region until the 15th. By the morning of the 16th the center of disturbance had reached the middle Gulf coast, and another disturbance that occupied the lower Mississippi Valley on the morning of the 15th had moved to the middle Atlantic coast. At 8 a. m. of the 17th the storms referred to had united off the southeast New England coast where the barometric pressure was below 28.90 inches. Passing slowly northeastward the storm center reached a position north of Scotland on the morning of the 23d, with central barometric pressure about 28.60 inches, and the barometer continued very low over that region until the close of the month.

While this storm was gathering over the southern Plateau a severe cold wave appeared in the extreme Northwest. By the morning of the 14th the temperature had fallen to 30° below zero in North Dakota, and the line of zero temperature extended into Minnesota and Nebraska and the central Rocky Mountain region. The movement of the cold wave was retarded by the area of low barometric pressure in the Southwest, but by the morning of the 16th the line of zero tempera-

ture had advanced eastward to the upper Lake region and southward into northern Texas. By the 17th practically the entire country east of the Rocky Mountains was under the influence of the cold wave, the line of zero temperature extending into Kentucky and Tennessee, and that of freezing temperature to the Gulf coast. Killing frost and freezing temperatures occurred in Florida as far south as Tampa, and the minimum temperature at Jacksonville, Fla., was 28°.

The cold wave, heavy snow, and gales that attended this storm were heralded in all districts by ample and timely forecasts and warnings, that permitted railroads and transportation companies in the central and northern districts, vegetable and fruit growers in the south, and shipping interests of the Gulf and Atlantic coasts to adopt precautionary measures. From the 14th to 17th the temperature fell below freezing at many points in southern California. Warning had, however, been given to orange growers.

The following comments were made in connection with the cold wave of the 16th and 17th by the daily press of New Orleans, La.

The Daily States, of February 16, 1903:

Reports received at the Weather Bureau office this morning show that the warnings were as usual timely. The watchfulness of the Weather Bureau, when conditions are threatening, can not be too highly commended, for no severe weather conditions reach this section without timely warning.

The Times-Democrat, of February 18, 1903:

The cold wave brought unseasonably cold weather to the Gulf coast. The temperature fell to 26.7° at New Orleans, 24° at Galveston, and 26° at Corpus Christi, which is almost the exact degrees named in the warnings sent out by the Weather Bureau.

The Picayune, of February 18, 1903:

The severest weather of the winter throughout the Southwest prevailed yesterday morning. Owing to the forecaster's timely notice and warning to planting interests, sugar, truck, and orange growers having been forewarned in ample time, there were taken the proper precautions for the freeze and severe injury was averted. This forecast having been implicitly believed by the agriculturists of the district, who had occasion last year to rely on Dr. Cline's accurate prediction, saved them many hundreds of thousands of dollars. When it is considered that such low temperatures do not occur in February more than once in eight or ten years, the successful forecasting thereof, in every instance of their occurrence, speaks much for the skill and efficiency of the Weather Bureau forecaster.

The following letter, dated February 21, 1903, was received by the Weather Bureau observer at San Antonio, Tex., from the president of the San Jose Truck Farm Company:

The daily weather forecasts, and particularly the cold wave warnings of the recent cold snap, have been of inestimable value to us. It was only through careful attention to the forecasts from the Weather Bureau and promptly acting on the warnings that we have managed to bring through, without loss of a plant, our crop of 35 acres of tomatoes.

Gales of unusual severity prevailed on the north Atlantic coast of the United States during the 16th and 17th and in New England snow fell to a depth of 15 to 20 inches.

The Boston Globe, of February 18, commented as follows regarding this storm:

The biggest storm that Boston has seen for at least five years ceased yesterday, although its effects will be felt for several days yet. The storm was heralded by the Weather Bureau Sunday night. This gave sea captains more than eighteen hours notice and doubtless saved many vessels and lives.

The other Boston papers also made favorable mention of the storm warnings and forecasts.

The next and last important storm of the month advanced from Arizona to the middle coast of the Gulf of Mexico from the 23d to the 27th, and, moving thence northeastward, united by the morning of the 28th with a storm that appeared over the middle Missouri Valley on the morning of the 27th, and moved thence over the upper Lake region by the morning of the 28th, with central barometric pressure about 29.15 inches.

Beginning on the 24th snow fell in the interior of the southwestern districts. The snowfall was unusually heavy in northern New Mexico, southeastern Colorado, Indian Territory, and portions of western Texas. At Amarillo, in the Texas panhandle, a total fall of 20 inches was reported. The snowstorm was followed by a cold wave of two days duration in the Southwest, with a minimum temperature of 10° at Amarillo.

The heavy rains that attended the passage of this storm caused rapid rises in the rivers of the Southern States and the Ohio Valley, in anticipation of which general flood warnings had been issued.

BOSTON FORECAST DISTRICT.

Heavy thunderstorms, a cold wave, a thaw, a heavy snowstorm, and gales of hurricane force occurred during the month. The most severe storm of the month was that of the 16-17th, when from 15 to 20 inches of snow fell over the district and gales of great force prevailed along the coast. Owing to the excellent work of the Weather Bureau, little if any damage resulted to shipping. The Bureau was highly commended by the press for giving timely warnings of the storm, thereby saving life and property.—*J. W. Smith, Forecast Official.*

NEW ORLEANS FORECAST DISTRICT.

Storms occurred along the Gulf coast on the 11th, 16th, and 26th, for which timely warnings were issued. At 1 p. m. on the 15th, when the barometer was falling over southeast Texas, Louisiana, and western Mississippi, cold-wave warnings were ordered for Arkansas, northern Louisiana, and southern Texas. The cold-wave warnings were extended to southern Louisiana at night. Reports at 8 a. m. of the 16th showed freezing temperature to the Texas coast and indicated the severest weather of the winter so far, and warnings were sent out that the temperature would fall to 20° in the sugar region and to 24° to 26° along the Gulf coast. On Wednesday morning the temperature was about 24° to 26° along the Gulf coast and 20° in the sugar region. Seed cane and other products were protected generally.—*I. M. Cline, Forecast Official.*

CHICAGO FORECAST DISTRICT.

The cold wave of most importance during the month developed over the British Northwest on the 12th. However, it remained over the Northwestern States without decided movement until the 15th. During the 15th and 16th it extended over the eastern and southern portions of the district. The movement of this cold wave was so tardy and irregular, causing gradually falling temperatures at many points, that warnings were issued only in the eastern and northwestern portions of the district, in advance of a moderate cold wave which was approaching from the Northwest. Three severe storms crossed the district during the month, which were attended by high winds and heavy snow north of their tracks. The first appeared in the Southwest at the beginning of the month; it moved eastward and northeastward toward the Lake region, accompanied by heavy rain, snow, and sleet, reaching the latter section on the 3d and 4th. The second storm was first noticed February 5 on the southern California coast. It followed nearly the track of its predecessor and crossed the southern Lake region on the 7th and 8th. The third also moved from the Southwest. It first crossed eastward to the lower Mississippi Valley, reached the Lake region February 14 and 15, and was followed by a cold wave. Warnings were issued to all railroads and transportation companies in advance of these heavy snowstorms, and, although traffic was maintained only with great difficulty, the advance warnings pre-

pared the various interests for the emergency, and rendered them valuable assistance.

Warnings were issued during the month from time to time to all open ports on Lake Michigan in advance of approaching storms. Vessel interests were especially advised of the dangerous storms of the 3d-4th, 7-8th, 14-15th, and 28th. These four storms were exceptionally severe, but no casualties of any kind were reported.—*H. J. Cox, Professor.*

DENVER FORECAST DISTRICT.

As a result of southwestern storms unusually cold weather was a feature throughout the district, especially in the northern part. In Colorado the month was not only the coldest February but also the coldest month in fifteen years. In anticipation of the development of a disturbance in the middle Plateau region, snow and decidedly lower temperatures were forecast on the morning of the 11th for the northern half of the district, and warnings of a cold wave were issued for Wyoming. The snowfall in northern Utah was very heavy. On the following morning warnings of the approach of severe cold weather were sent to southern Utah and western Colorado. Hemmed in by the Continental Divide and the additional barrier of a high area, reenforced from time to time, on the eastern slope, the low area remained practically stationary in northern Arizona until the afternoon of the 15th, a distribution of pressure that gave uninterrupted and abnormally cold weather in Utah, Wyoming, and Colorado until early in the morning of the 16th, when a depression began to develop in southeastern Wyoming. This low was attended by high winds in Wyoming and northeastern Colorado, uncovering the grass for range stock, and at the same time drifting the unpacked snow into railroad cuts. On many lines it was several days before it was possible to resume traffic. The fair and comparatively fine weather of the succeeding week was exceedingly fortunate for range stock which had been suffering severely from the cold and lack of feed, but where it was possible to heed the warnings by gathering and feeding no losses were incurred. Snow in southeastern Colorado and New Mexico was forecast for several days beginning with the 23d. The snow fall was unusually heavy in northern New Mexico and throughout southeastern Colorado.—*F. H. Brandenburg, Forecast Official.*

SAN FRANCISCO FORECAST DISTRICT.

The month was an unusually quiet one, as February is generally a stormy month on this coast. Generous rains prevailed at the beginning of the month over the southern and central portions of the State, with heavy snow in the mountains. Heavy frosts in southern California on February 3 were accurately forecast. Southeast storm warnings from San Francisco on February 3 were verified. Generous rains prevailed on February 4 in southern California and frost warnings were again verified. Southeast storm warnings were displayed along the coast on February 7 and were verified north of Point Conception. At Point Reyes the wind reached a velocity of 74 miles per hour from the southeast. Beginning about February 10 a succession of high areas prevailed over northern California and northern Nevada. A depression of moderate depth remained over Arizona and the valley of the Colorado for several days. Killing frosts occurred generally north of the Tehachapi on February 14, 15, 16, and 17 and temperatures below freezing were reported at many points in the citrus fruit belt of southern California. Ample warning of these frosts was given to the orange growers and extensive smudging was pursued. During the last decade of the month the weather was fair and pleasant with the exception of the 22d, when a small

disturbance prevailed off the coast of northern California.—
A. G. McAdie, Professor.

PORTLAND, OREG., FORECAST DISTRICT.

During the first decade of the month two severe storms passed over the district, for which timely warnings were issued. The unusually high wind velocities of 72 miles southwest at Tatoosh Island, and 80 miles south at North Head occurred during the night of the 8th. Just at the close of this stormy period the German bark *Alsternixie* stranded at the mouth of the Columbia River while attempting to sail across the bar without a pilot. No lives were lost and the ship was afterwards floated and safely dry docked. From the 11th until the close of the month fair weather generally prevailed in consequence of disturbances appearing too far south to cause rain in the North Pacific States. Incoming vessels reported few storms east of the one hundred and eightieth meridian along the northern track of steamers plying between Asiatic and north Pacific ports.—E. A. Beals, Forecast Official.

AREAS OF HIGH AND LOW PRESSURE.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocity.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.										
I.....	1 a. m.	53	108	7 a. m.	32	65	3,175	6.0	529	22.0
II.....	4 a. m.	45	123	8 a. m.	47	65	2,825	4.0	706	29.4
III.....	6 p. m.	39	120	10 a. m.	37	76	2,950	3.5	843	35.1
IV.....	12 p. m.	54	114	16 p. m.	47	101	725	4.0	181	7.5
V.....	14 a. m.	47	123	18 a. m.	30	82	2,900	4.0	725	30.2
VI.....	17 a. m.	53	105	20 a. m.	32	65	2,800	3.0	933	38.9
VII.....	19 p. m.	44	116	23 p. m.	32	65	3,100	4.0	775	32.3
VIII.....	22 a. m.	54	114	25 p. m.	40	75	2,250	3.5	643	26.8
Sums.....							20,725	32.0	5,335	222.2
Mean of 8 paths.....							2,591		667	27.8
Mean of 32.0 days.....									648	27.0
Low areas.										
I.....	1 a. m.	39	120	5 p. m.	46	60	3,600	4.5	800	33.3
II.....	4 a. m.	34	118	9 p. m.	46	60	3,925	5.5	714	29.8
III.....	7 a. m.	48	123	12 p. m.	46	60	3,300	5.5	600	25.0
IV.....	8 p. m.	35	112	17 p. m.	46	60	3,450	4.0	862	35.9
V.....	14 p. m.	35	112	17 p. m.	46	60	2,350	3.0	783	32.6
VI.....	19 a. m.	54	114	22 p. m.	46	60	2,625	3.5	750	31.2
VII.....	25 a. m.	32	106	28 p. m.	48	68	2,925	3.5	836	34.8
Sums.....							22,175	29.5	5,345	222.6
Mean of 7 paths.....							3,168		764	31.8
Mean of 29.5 days.....									752	31.3

For graphic presentation of the movements of these highs and lows see Charts I and II.—Geo. E. Hunt, Chief Clerk, Forecast Division.

RIVERS AND FLOODS.

At the end of February there was considerably more ice in the rivers of the northern districts than at the corresponding date of 1902, although the upper Mississippi was not frozen so far to the southward. The increase varied from 1 to 7 inches in the upper Mississippi and from 4 to 10 inches in the Missouri. The actual thickness in inches at a few selected stations was as follows: Moorhead, Minn., 38; Bismarck, N. Dak., 33; Sioux City, Iowa, 24.5; Omaha, Nebr., 14.5; St. Paul, Minn., 24, and Davenport, Iowa, 14.5.

The river stages of the lower Missouri and upper Mississippi did not differ materially from those of the preceding month.

Over the Ohio Valley, the Gulf and Atlantic States, however, the precipitation was frequent and heavy, ranging from 2 to 10

inches above the normal amount without any unusually low temperatures. As a consequence, all the rivers of those districts rose to flood stages. The Mississippi below the mouth of the Ohio had passed the danger line at all points and was still rising steadily at the end of the month. Reports of these floods are given below, except those of the lower Ohio, lower Mississippi, and the Tennessee, which will be published later.

PITTSBURG DISTRICT.

By Mr. Frank Ridgway, Official in Charge of the United States Weather Bureau office, Pittsburg, Pa.

The conditions prevailing on the morning of the 3d throughout all sections southwest of Pittsburg indicated rising temperatures, heavy rains accompanied by thawing, and general thawing conditions over the Allegheny and Monongahela valleys, and, as a consequence, high water. As all of the ice had passed out of the Allegheny and Monongahela rivers and their tributaries during the last week of January, a rise at this time could be caused only by the melting of what snow remained in the mountains and by heavy rains. On the 3d the rivers had begun to show the effect of the melting and during that night they were steadily rising. In addition to this, heavy rains were falling, due to the storm development in the southwest. At 8 a. m. of the 4th the rivers showed a rise at Pittsburg of about 4 feet, and reports indicated that all of the tributaries were rising steadily and that heavy rains were falling as anticipated. The upper river stations were immediately called upon for special hourly observations, and these showed an average rise of 0.2 to 0.5 foot an hour in all of the streams. At noon preliminary advices were sent out in all directions through special editions of the newspapers and by means of the telephone that all interests affected by high water should keep in touch with the Weather Bureau office night and day.

At 4 p. m. I informed the police departments of Pittsburg and Allegheny that all interests in the lower districts of their respective cities should be notified to make preparations for a stage of 23 feet by Thursday morning, February 5, and that all property affected by a stage of 25 feet should be moved at once. This information was also given to the press, which promptly published the same. The rivers rose slowly and steadily all that day and throughout the night. The danger line of 22 feet was passed at 3 a. m. of the 5th, and the maximum stage of 24 feet was attained at 9 a. m. of that day, making a total rise of about 7 feet in eighteen hours.

Mr. Ridgway also made the following report on the moderate flood of the 16th, when a 22-foot stage was reached at Pittsburg:

On the morning of the 16th the reports from the Monongahela and Kiskiminitas rivers and tributaries showed that heavy rains had fallen and that the rivers were rising rapidly. The stage at Pittsburg was then 12.9 feet, a rise of nearly 3.0 feet during the previous twelve hours. Special hourly reports were at once called for, but before they were received warnings were issued through the departments of police of Pittsburg and Allegheny, through the noon special editions of the press, by telephone, and by telegraph, notifying all concerned to make preparations for a stage of 22.0 feet, or over, at Pittsburg by midnight. Inspection of the special reports from the upper river stations soon disclosed the fact that the maximum would not be over 22.0 feet, as the Kiskiminitas, Monongahela, and tributaries were contributing all the water, the Allegheny River above Freeport doing practically nothing, as the heavy rains had not reached the upper Allegheny and tributaries, and what did fall there was controlled by low temperature. At midnight the stage at Pittsburg was 21.5 feet, a rise of 8.6 feet since 8 a. m., or a total rise of 11.7 feet. The river was then rising about two-tenths of a foot an hour, with all the upper streams about stationary. The maximum stage reached was 21.9 feet at 2 a. m. of the 17th, at which height it remained stationary until 4 a. m., when the water commenced to fall. At 8 a. m. of the 17th it showed a stage of 21.3 feet and was falling at the rate of 0.2 of a foot an hour. No warnings were necessary for points below Pittsburg.

CINCINNATI DISTRICT.

By Mr. S. S. Bassler, Official in Charge of the United States Weather Bureau office, Cincinnati, Ohio.

During the month of February, 1903, there were two overflows of the Ohio River, neither of which, however, quite reached the danger line in the Cincinnati district, except at Point Pleasant, W. Va.

On February 2 there was a decided local rise of 11.3 feet during the twenty-four hours ending at 8 a. m. Heavy rainfall in the immediate region caused a rapid rise in the neighboring streams emptying into the Ohio near this point. Truck gardens were overflowed and much early vegetable stuff destroyed. Traction lines suffered considerably and traffic was delayed. Merchants in the "Bottoms" became anxious about the rising water, and kept in touch with the Weather Bureau office. They

were individually informed through the telephone of approaching stages, rendering removal of goods from cellars necessary.

A local warning was issued that the river would reach the danger line, 50 feet, but all business interests that could stand 51 feet were advised that under present conditions they would not be disturbed.

High winds and a cold wave following the rains undoubtedly checked the rise of the river, which kept coming up slowly until a stage of 49.4 feet was reached at 7 p. m. of the 8th, 0.6 of a foot below the official danger line.

No damage was done in the city and there was no suffering due to high water, but there was much loss to garden truck in the rich bottoms in the vicinity, and much valuable timber, among other drift, floated by the city.

On the 5th a warning was telegraphed to Point Pleasant, W. Va., that the river there would exceed the danger line, 39 feet, by several feet, and on the 6th, a danger-line warning, 50 feet, was sent to Portsmouth, Ohio, mainly because of the behavior of the Scioto emptying into the Ohio at that point. The warning to Point Pleasant was verified, the river there reaching about 41 feet on the morning of the 7th. The warning to Portsmouth fell short about two feet. By the morning of the 8th the entire river above Cincinnati was again falling.

Heavy rains on Sunday, the 15th, resulted in another rapidly rising river from Pittsburg down. At Cincinnati the stage had receded to 30.3 feet. A sharp rise was forecast, the local stage to exceed 45 feet by the evening of the 17th, which it did at 10 p. m. Merchants in the "Bottoms," though but recently recovered from a flood scare, renewed preparations for high water. All affected by less than 50 feet were advised to immediately clear out their cellars. On the morning of the 17th warning was telegraphed to Point Pleasant that the river would pass the danger line that night. The situation was believed to be sufficiently serious to warrant a general warning, that the river would exceed the danger line throughout the Cincinnati district, and warning was sent on the 17th to the observers at Huntington, W. Va., Catlettsburg, Ky., and Portsmouth, Ohio, to this effect. But high winds and cold weather again prevented the water from coming to as high a stage as it undoubtedly would have reached under other circumstances. At Point Pleasant it reached a crest stage of 40.8 feet at 9 p. m. of the 17th; at Huntington, W. Va., it stopped at 47 feet during the night of 17-18th; and at Catlettsburg it stopped at 47.1 at about 7 p. m. of the 18th; at Portsmouth the crest stage was 47.7 at 3 a. m. of the 19th, and at Cincinnati, after several periods of inactivity it reached the maximum stage of 49.4 at 9 p. m. of the 19th, where it remained stationary until 11 a. m. of the 20th when it began to fall.

CHATTANOOGA DISTRICT.

By Mr. L. M. Pindell, Official in Charge of the United States Weather Bureau office, Chattanooga, Tenn.

The lowest water stage during the month was 4.8 feet on the 1st. The river rose slowly until 6 a. m. of the 3d when the rate of rise increased, becoming rapid after 1:30 a. m. of the 4th, owing to the heavy rainfall over the river system. The river became stationary at 6:40 a. m. of the 6th, with 19.6 feet on the gage; it began to fall after 1 p. m. on the 6th and continued to fall slowly until the 11th, when heavy rains again occurred causing nearly a 2-foot rise by 6 p. m. of the 11th; it fell steadily from 9 a. m. of the 13th to 7 a. m. of the 16th. Rain set in over the system on the 15th and continued until the 17th. The river began to rise rapidly after 1:30 p. m. on the 16th and reached a crest of 29.5 feet at 4:15 p. m. on the 19th. On the 17th, a stage was forecast of about 30 feet by Wednesday night, the 18th, with the crest below the danger line. The lower river at Riverton, Ala., passed the danger line and reached a crest of 28.7 feet on the 20th and 23d, or 3.7 feet above the danger line, and at Florence, Ala., it reached 17.7 feet on the 22d, or 1.7 feet above the danger line. The river at Chattanooga began to fall after 6 a. m. of the 20th; the rate of fall was rapid from 10 p. m. of the 20th to noon of the 23d, then slower to noon of the 27th when another rainstorm passed over the system, producing copious rains over the central portion, from Bridgeport, Ala., to Clinton and Knoxville, Tenn. The river began to rise at 7 p. m. on the 27th and rose very rapidly during the 28th, reaching 23.5 feet at 11:59 p. m. The river forecast issued Saturday morning, February 28 was as follows: "The river will rise very rapidly to-night and slower Sunday (March 1). A stage of 27 feet is expected by 8 a. m. Sunday. The crest will occur between Sunday night and Monday morning, and will be about 31 feet." The river reached 31.1 feet at 11:40 a. m., Monday, March 2. The rapid rise in the river at Chattanooga and over the headwaters had reached Bridgeport, Ala., when the month closed, and the conditions were favorable for the rise near Florence and Riverton to continue for the next seven or eight days and for the river to near the 20-foot mark at Florence and the 30-foot mark at Riverton. The month closed with the river rising rapidly. The copious rainfall of the 27-28th, caused washouts and landslides on the various railroads, delaying traffic and causing a heavy loss to the various companies. The most serious accident was the wreck of passenger train, No. 30, on the main line of the Southern Railway near Lenoir, Tenn.; 3 persons were killed and 22 injured; all mail was destroyed. No losses occurred above Bridgeport, Ala.

RICHMOND DISTRICT.

By Mr. E. A. Evans, Official in Charge of the United States Weather Bureau office, Richmond, Va.

Precipitation rather general, though light in character, prevailed over the State during the 14th and 15th, wetting the ground thoroughly and raising the volume of water carried by the James River somewhat above the normal for the time of year. This period of precipitation was closed by the severe storm of the 16th, when high winds with rain, sleet, and moist snow occurred, the total amounts deposited ranging from 1.00 inch to about 2.50 inches. Owing to the saturated soil and the decreased evaporation incident to the season a rather high percentage of run-off occurred and though the resulting flood heights were within quite moderate limits, the proportion of rise to precipitation was greater than usual.

On the early morning of the 17th telegrams from several of the special river and rainfall stations showed rising water in the James River and tributaries, and at 9 a. m. an advisory warning of a 12-foot stage at Richmond was issued, the rise to occur by the morning of the 18th. During the day there was a slow but steady rise and toward midnight the water began to approach the dock level at the wharves of the various navigation companies. By the morning of the 18th the river had covered the docks of the Virginia Navigation Company, the Clyde and Old Dominion Steamship Lines, and had encroached upon the street car tracks of the Virginia Passenger and Power Company at the depressed portion of Lester street, near the river, interrupting traffic and making transfer of passengers by row boat necessary. The water remained high during the day covering the steamboat wharves to a depth of 2 to 5 feet, but at night began to recede slowly and by the afternoon of the 19th was almost within the banks of the river.

The usual means were taken to distribute the warnings and they were effective, no damage occurring as far as could be ascertained.

The cold weather following immediately on the heels of the storm causing the flood was of great assistance in checking the run off and undoubtedly prevented a higher stage of water.

The forecast called for a 12-foot stage by the morning of the 18th and the maximum stage reached was 11.9 feet at 8 a. m. on that day.

CHARLESTON DISTRICT.

By Mr. L. N. Jesunofsky, Official in Charge of the United States Weather Bureau office, Charleston, S. C.

The streams of South Carolina were at high stages throughout the entire month of February, and there were four distinct flood periods, viz., 5-6th, 8-9th, 12-13th, and 17-19th, corresponding closely with the heavy rainfalls over the upper drainage areas of the 3d-4th, 7-8th, 10-11th, and 15-16th.

The Wateree River at Camden, S. C., rose 15.6 feet during the 5th and 6th; 11.7 feet on the 8th and 9th; 7.0 feet on the 12th, and 13.7 feet on the 17th and 18th. The river was above the danger line during the 8th, 9th, 10th, 12th, 13th, 18th and 19th.

At Cheraw, S. C., on the Pedee River, there was a rapid rise of 20 feet on the 5th and 6th. An additional rise of 11.3 feet on the 8th and 9th forced the water up to the 31.3-foot mark, or 4.3 feet above the danger line. There was a slow rise from 8 a. m. of the 9th to 4 p. m. of the 10th, at which time the maximum gage reading of 31.6 feet was recorded. On the morning of the 11th, although the river was falling rapidly, the gage reading 23.8 feet, the decline was suddenly checked by another rise which forced the water up to a gage height of 26.6 feet on the 12th, and 28 feet at the 8 a. m. observation of the 13th. The river remained above the point of danger for thirty-two hours, after which it receded rapidly for three days. On the 17th, with a stage of 15 feet at 8 a. m., it commenced to rise slowly, and by the 8 a. m. observation of the 18th, had risen to a height of 28.8 feet, or 1.8 feet above the point of danger. At 4 p. m. of the 18th the gage showed a reading of 29.9 feet, and at 7 a. m. of the 19th a stage of 30.4 feet was recorded. On the morning of the 20th a rapid fall was again in progress.

The Congaree River at Columbia, S. C., was 4 to 5 feet above the danger line on the 8th and 9th, when there was a rise of 16.7 feet. At 6 a. m. of the 8th the gage read 19.3 feet, and at 12 noon, 20.5 feet. The water remained stationary from this time until 9 a. m. of the 9th, when it began to recede slowly.

Heavy rainfall on the upper Broad River during the 15th and 16th brought the Congaree River to a stage of 16.7 feet on the morning of the 18th, a rise of 12.9 feet since the previous morning. There was a decline of 13.7 feet from the 19th to the 22d, inclusive.

The lower Pedee at Smiths Mills, S. C., began to rise rapidly on the 12th, and reached the danger line on the 16th. From the 17th to the 19th, inclusive, it remained stationary at a stage of 17.4 feet, 1.4 feet above the danger line, and began to recede slowly during the morning of the 20th, falling below the danger line on the morning of the 28th.

The flood waters in the Wateree and Congaree rivers produced very high stages in the Santee River at St. Stephens, S. C., from the 15th to the 26th, during which period the stream was above the danger line.

Warnings were, as a rule, well distributed previous to the approach of

the flood waters, and but little damage was reported, except at Camden, S. C., on the 8th and 9th, where the rising waters tore away a portion of a dam entailing considerable loss. The flood of the last two days of the month continued during the early days of March and will be mentioned in the WEATHER REVIEW for that month.

MACON DISTRICT.

By Mr. J. R. Weeks, Official in Charge, of the United States Weather Bureau office, Macon, Ga.

The weather chart on the morning of the 7th did not afford sufficient indications of heavy rains to justify cautionary river warnings, but by that evening it was seen that there would probably be a brisk rise in both the Ocmulgee and Oconee rivers, and the local press were so informed, the public being advised that a brisk rise might be expected and that stockmen and others should be on the lookout. At 8 a. m. of the 8th the river at Macon having risen 11.3 feet during the past twenty-four hours, the fact was communicated in a special bulletin to river addresses below Macon as far as Hawkinsville, Ga. At 10 a. m. a second bulletin was issued to all river addresses and the local press, containing the following forecast: "A brisk rise may be expected in the Oconee and Ocmulgee rivers, covering lowlands and passing Hawkinsville, Ga., Monday night, Abbeville, Ga., Thursday or Friday, and Evergreen, Ga., Sunday or Monday of next week. In the Oconee River the crest will reach Beech Hill and Oconee, Ga., Monday or Tuesday, and Dublin, Ga., about the middle of the week (this week)." The rainfall in the river district for the twenty-four hours ending at 8 a. m. was as follows: Covington, 2.20 inches; Macon, 1.52 inches, and Milledgeville, 2.52 inches. The river at Macon continued to rise during the day, covering the lowlands and surrounding the houses in the bottoms, until at 4 p. m. it was 21.0 feet, or 3 feet above the danger line, and about on a stand. A bulletin was then issued to all river addresses containing this information and the following forecast: "Be prepared for a freshet not quite equal to that of March, 1902." The river rose very slightly during the night and at 8 a. m. of the 9th was 21.2 feet, or 2 feet below the freshet of March, 1902. It began to fall during the day and by the morning of the 10th was 18.4 feet. The morning chart on that day, however, showed that rain would fall that night and the next day, and might be heavy; a special edition of the weather map was, therefore, issued to all river addresses and contained the following caution: "Important. All river interests should watch conditions carefully in regard to freshets in Oconee, Ocmulgee, and Altamaha rivers. Should heavy rains occur to-night or Wednesday in upper districts communication by mail will undoubtedly be interrupted from Macon to most points below. Stock should be removed from lowlands and preparations made to care for movable property if necessary. The freshet passed Macon Monday morning with a stage of 21.2 feet, but might be increased and hastened should heavy rains fall in next twenty-four hours."

By the next morning (February 11th) the freshet in the Oconee reached Dublin, the gage at that place showing a rise of 10.0 feet, and a stage of 21.0 feet. A special edition of the morning weather map issued to river addresses contained the following information: "The river at Dublin rose 10 feet in the past twenty-four hours; it will continue to rise more slowly to-day and probably Thursday, about equaling the freshet of 1902. Heavy rains occurred last night as follows: Atlanta, 1.48 inches; Covington, 1.70 inches; Milledgeville, 1.08 inches; Dublin, 0.52 inch; Macon, 1.14 inches. This will cause a second rise in the Ocmulgee, the crest passing Macon to-morrow, which will equal and may exceed the freshet of 1902. Rain continued at Atlanta this morning."

The forecasts for the Oconee and previous forecasts for the Ocmulgee were fully verified, but the rapid fall in the Ocmulgee before the second rain and the fact that the larger amounts were in the extreme upper portion of the district made the river fall, fortunately, to reach as high stages as were expected for the second rise. It rose, however, to danger line and continued high during the day and night. The rise in the Oconee passed Dublin February 13 with a stage of about 25 feet, almost equal to the freshet of March, 1902.

As far as possible the public was kept fully advised of river conditions during this period, and the office was kept very busy preparing the bulletins and answering inquiries. Active steps were taken by all river interests to care for property, and, because of this, the damage caused by the freshet is believed to have been comparatively slight. The railroads between Atlanta and Macon and to the southeast were inconvenienced because of high water and a few families living in the bottoms were compelled to move from their homes. The Macon Telegraph on the 9th spoke as follows: "These warnings, together with the caution published in the Telegraph yesterday, will give all parties—rice planters, rivermen, stockmen, and others ample time to prepare, in fact from a day at Hawkinsville to nearly three weeks at Darien. An idea of the river interests in southeast Georgia can be gained from the fact that \$140,000 worth of property was reported saved in March of last year because of warnings issued from the Macon office of the Weather Bureau and published in the Telegraph."

The bulletins and warnings are greatly appreciated by the many recipients and are at once distributed by them to their neighbors. The Erie Lumber Company, Lumber City, Ga., through its secretary and

treasurer, says: "These reports are almost a godsend to rivermen, boatmen, and officers having roads and bridges to protect." Numerous similar commendations from others have been received. Mr. N. L. Grayson, United States Overseer, Hollingsworth Ferry, Ga., states that he received the warning one hundred and sixty-eight hours before the crest of the rise reached him. Owners of property valued at between \$25,000 and \$75,000 from Jacksonville to Hawkinsville, Ga., were at once notified by steamboat, and about 90 per cent of it was saved, together with timber and Government property in his charge, because of the warnings. The total value of the property saved by the warnings was about \$150,000.

MONTGOMERY DISTRICT.

By Mr. F. P. Chaffee, Official in Charge of the United States Weather Bureau office, Montgomery, Ala.

Moderately heavy rains occurring over the watershed of the upper Coosa River during the early morning of the 7th instant, and the weather conditions being such as to portend still heavier rains over this region, special 3 p. m. reports were called for from all substations, and advisory warnings issued for those interested in the rivers to keep in close touch with this office. The 3 p. m. reports showing continued heavy rains over middle Alabama, warnings were issued at 5 p. m. that the heavy rains would continue through the following night, and that river stages of 25 feet, or more, would be reached at Wetumpka, Montgomery, and Selma, Ala., during the next day, with continued rise during the two or three days following.

Morning reports of the 8th showing the 24-hour rainfall as ranging from about an inch over the upper portions of the State to 4 inches at Selma and Milledgeville, Ala., with the Coosa, Alabama, and Tallapoosa rivers rising very rapidly, flood warnings were issued for all points from Gadsden to below Selma, Ala., the following stages to be reached, if not exceeded:

Gadsden 19, and Wetumpka 45 feet during following night; Montgomery 42 feet during following morning, and Selma 46 feet within next two days; advice was also given that live stock and other perishable property from above Wetumpka to 100 miles below Selma should be moved to high ground.

During the 9th the river went to one foot above the danger line at Gadsden, and attained 45 feet at Wetumpka and 41.2 feet at Montgomery. By the morning of the 10th it had reached 45.9 feet at Wetumpka, beginning to fall slowly after that time; at Montgomery it reached 45.6 feet the evening of the 10th, and was stationary for about two hours; at Selma it continued to rise slowly, reaching 41 feet at 3 p. m.

Additional heavy rains over the drainage area of these rivers during the night of the 10-11th started secondary rises, and supplementary warnings were issued on the morning of the 11th for slightly higher flood stages in the upper Coosa, and for stages of about 50 feet at Wetumpka and Montgomery, and 52 feet at Selma; advice was also given that residents in low grounds of north Montgomery, which is flooded at about 48 feet, should move their household effects to higher ground. On the morning of the 12th the estimated maximum stages for Wetumpka and Montgomery were lowered to about 49 or 49.5 feet and for Selma to about 51 feet.

The flood crest (47.2 feet) passed Wetumpka about 5 p. m. of the 11th, Montgomery (48.6 feet), about 1 p. m. of the 13th, and Selma (50.6 feet), at 8 a. m. of the 15th.

The distribution of the warnings of these floods gave the first thorough trial of the scheme perfected last summer, by which each substation repeats the warnings to all points within a certain district. The plan worked most satisfactorily and gave the widest possible dissemination of the information. The warnings were so far in advance of the high waters as to receive the hearty commendation of the press.

The value and appreciation of the warnings is best shown by the following extract from the Montgomery Journal of February 14, 1903:

"Now that the flood danger is about over, it seems proper to note the great value the freshet and flood warnings of the Weather Bureau have been to the various interests of this section. Had the high water come unheralded, the loss of life in the low grounds might have been considerable, and the property loss certainly would have been great. As it is, not a single loss of life has been reported from the freshet, and the property loss was comparatively slight."

"It certainly shows the inestimable value of the river and flood service of the Weather Bureau."

Flood stages were also experienced in the Susquehanna, lower Roanoke, Cape Fear, Savannah, Chattahoochee, Tombigbee, and Black Warrior rivers. The usual warnings were issued at the proper time, and no reports of serious damage have been received.

The floods in the White, Black, Ouachita, Red, and Atchafalaya rivers continued at the close of the month, and the descriptions thereof will be included in the report of the lower Mississippi flood, which will be issued at a later date.

The heavy rains of the 25th and 26th over the Texas watershed caused rapid, dangerous, and destructive rises in the rivers of that State a few days later. General warnings were widely disseminated on the 26th. The report of this flood will appear in the WEATHER REVIEW for March, 1903.

During the month the River and Flood Service was extended to the Passaic River of New Jersey, with headquarters at Philadelphia, Pa., and the Hudson River service, Albany, N. Y., district, was greatly enlarged and improved.

Stations were established on the Passaic River and tributaries as follows: On the Passaic River at Chatham, N. J.; on the Rockaway River at Old Boonton, N. J.; on the Ramapo River at Mahwah, N. J., and on the Pompton River at Pompton Plains, N. J.

This service will be maintained with the cooperation of The Society for Establishing Useful Manufactures, Paterson, N. J., through its Chief Engineer, Mr. John H. Cooke. While the Passaic River is a comparatively small stream, its total drainage area being but 949 square miles, it is nevertheless an extremely important one on account of the great commercial interests located along its lower portion and dependent upon it for

power. The Passaic floods are sudden and at times dangerous and destructive to both commercial and agricultural interests, and it is hoped that the new service will be able to give timely and effective warnings of approaching flood waters.

For the benefit of the Hudson River service new stations were established as follows, all within the State of New York: On the Hudson River at Corinth, Glens Falls, Mechanicsville, Cohoes, Troy, Castleton, and Stuyvesant; on the Mohawk River at Utica, Little Falls, Fort Hunter, and Schenectady; on Schroon River at Warrensburg; on the Sacandaga River at Northville; on the Hoosick River at Hoosick Falls and Schaghticoke; on Schoharie Creek at Schoharie Junction and Millpoint, and on West Canada Creek at Trenton Falls.

The highest and lowest water, mean stage, and monthly range at 167 river stations are given in Table VII. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—H. C. Frankenfield, *Forecast Official*.

CLIMATE AND CROP SERVICE.

By Mr. JAMES BERRY, Chief of Climate and Crop Service Division.

The following summaries relating to the general weather and crop conditions during February are furnished by the directors of the respective sections of the Climate and Crop Service of the Weather Bureau; they are based upon voluntary reports from meteorological observers and crop correspondents, of whom there are about 3000 and 14,000, respectively:

Alabama.—Excessively wet and unfavorable; very little farm work was done, though some corn and cotton land was prepared in southeast counties, where rainfall was least; floods in all large streams and much lowland inundated. Severe cold wave of 17-18th killed young oats, very early fruit, and nearly all early trucking crops; wheat and fall sown oats were slightly damaged. Fruit prospect doubtful, as recent damage by freeze can not be determined until later in the season.—F. P. Chaffee.

Arkansas.—Farming operations were delayed by continued unfavorable weather; the ground was too wet to plow and very little of this work was accomplished; some cotton remains unpicked and can not now be gathered. Early sown wheat and oats were in good condition generally, but it is believed that the late sown were injured by too much rain. Indications are that the entire peach crop was apparently destroyed by the cold snap; the buds were frozen and killed in almost every section, though reports were more favorable in some localities. Apples, pears, and small fruits were not injured.—Edward B. Richards.

Arizona.—The weather during the greater part of February was abnormally cold; the precipitation was generally in excess of the normal, but in some localities there was a deficiency; the greater part of the precipitation fell during the first decade. The supply of irrigation water was adequate and will be ample the rest of the season. Grain and alfalfa and the ranges generally were in good condition. Frozen ground has delayed seeding in some localities, and many peach and almond blossoms were killed by frost. Stock has suffered somewhat by severe weather in the colder portions of the Territory.—M. E. Blystone.

California.—Abnormally low temperatures prevailed throughout the State until near the close of the month. Severe frosts caused some damage to citrus fruits, and the continued cold and cloudy weather retarded the growth of grain and grass. Deciduous fruit trees were benefited by the cold, which checked premature budding. Early wheat was in good condition and early fruits were in blossom at the close of the month.—Alexander G. McAdie.

Colorado.—Over a comparatively small area in the center of the State, in Lake, Summit, Eagle, and the northern part of Gunnison counties the total snowfall was considerably less than normal, but in general other parts of the mountain region appear to have had the normal amount or an excess. The bulk of the current fall has been swept into huge drifts in the timber, gulches, etc., where it is likely to remain hard packed and practically solid ice until after later snowfalls have melted.—F. H. Brandenburg.

Florida.—The month was warmer than the average, with an abnormal amount of precipitation, the latter having a very unfavorable bearing on the vegetable crop. Over portions of Dade County the losses were quite heavy, prospects being reduced one-half. The warm, cloudy weather was very favorable to citrus trees, which made a splendid growth. Early corn was pushing forward, and land is largely prepared for cotton. A small

acreage was planted to melons. The month was unfavorable to strawberries.—A. J. Mitchell.

Georgia.—The chief meteorological features of the month were the high mean temperature, the heavy rainfall in the northern and western sections, and the severe cold wave of the 16th to 18th. The temperature was characterized by three periods of unseasonably warm weather. From the afternoon of the 16th to the morning of the 17th the temperature fell 40° to 60°. The rainfall was the heaviest on record for February since 1892. The total monthly amounts exceeded 13 inches at several stations. Little or no farm work was accomplished. The cold wave of the 16th to 18th was especially injurious to peaches in the northern section, but in the middle and southern fruit belts the effects of the cold weather were less marked. Winter wheat and oats were in good condition.—J. B. Marbury.

Idaho.—The records for the month showed unusual deficiency in both temperature and precipitation; no greater extremes of cold were experienced than in previous years, but the cold was continuous throughout the month, the mean at many places being the lowest ever known; precipitation was mostly in the form of snow, slightly increasing the depth of snow at very high elevations, but not adding materially to the supply throughout the State; at the close of the month the snow was drifted considerably and well packed.—E. L. Wells.

Illinois.—The temperature was above the seasonal average the first half of the month; a period of cold weather of unusual severity prevailed from the 16th to the 20th; the precipitation was very unevenly distributed; a general and opportune snowstorm began on the night of the 14th, and it afforded ample protection to wheat during the ensuing cold wave. Wheat was in a promising condition at the end of the month. Fruit sustained injury from cold in the southern district.—William G. Burns.

Indiana.—Snow covered the ground in the north section throughout most of the winter and in the central and southern sections during the severe cold weather, affording good protection to wheat, and the crop at the end of February was unusually promising; rye, clover, and other grasses were also in fine condition; on account of the snow in the north section and rough or muddy fields in the central and southern sections considerable corn remained in the fields at the close of the month. Many correspondents in the southern section reported on the last of February that most if not all peach buds were dead.—W. T. Blythe.

Iowa.—Month generally favorable for stock and for farm operations usual in winter; fall wheat, rye, and grass were not materially affected by low temperature; at the close of the month snow had disappeared and the weather was spring like.—John R. Sage.

Kansas.—A cold month; the first and last days were warm and the middle portion cold. Wheat was well covered with snow during the cold part and was further benefited by the wet snow of the 24-27th, and was in good condition. Ground too wet for plowing or oat sowing in south. Some corn in field damaged by wet snow. Peach buds reported killed in central counties.—T. B. Jennings.

Kentucky.—Crops were fairly well protected by snow during the severe weather. In the western counties some damage was caused by floods. Early sown wheat was in excellent condition and the outlook for the crop as a whole was encouraging. Rye and oats were in good condition. Farm work was badly delayed; very little was done toward burning to-

bacco beds until the last of the month. Early peaches and early cherries have probably been injured by the freeze.—*H. B. Hersey.*

Louisiana.—General rains fell on fifteen days, and the ground was too wet for cultivation throughout the entire month. Preparations for cotton planting were much behind average seasons. Corn planting could not be commenced, and very little preparation for the crop has been made. Dry weather was needed for the sugar cane crop. Planting has been materially retarded, and much seed cane is sprouting in the windrows. Very little rice has been planted. Truck gardens where protected from the severe freeze during the second decade of the month were doing well, but where the warnings were not heeded the crops were killed.—*I. M. Cline.*

Maryland and Delaware.—Wet weather was somewhat hurtful to wheat in lowlands, but the crop as a whole was in a satisfactory condition, especially in the upper counties, where heavy snows on the 16th and 17th afforded ample protection during the cold that followed. Some peach buds were reported killed by the severe temperatures. All grasses were in fair to good condition. Some clover being seeded. Many tobacco raisers were seeding their beds. Farming operations generally have moved slowly on account of the frequent rainy spells.—*Oliver L. Fussig.*

Michigan.—Winter wheat was well protected from the 2d until the warm rains of the last few days of the month; it was especially well protected during the severe cold wave of the 16th to 19th. Correspondents generally agree that no injury occurred. At the close of the month most fields were bare; in many places low, level fields were covered with water, which might do damage if weather favorable for freezing and thawing ensued. The general opinion of correspondents was that all fruit trees had wintered well and were in a promising condition.—*C. F. Schneider.*

Minnesota.—Decidedly cold weather from the 12th to the 20th, with minimum temperatures below zero in all parts of the State, and below -40 in northern-central portions. The mean temperatures were slightly above the normal in the Red River Valley and in some other parts of the north, and it was cooler than usual in southern portions; the average for the whole State was slightly lower than the normal. There was less snowfall than usual; the snow depth averaged from 3 to 9 inches in the open country to much greater depths in the timber.—*T. S. Outram.*

Mississippi.—Heavy to excessive rains were quite general during the first 16 days of the month and during the last 3, while from the 16th to the 25th generally fair weather prevailed. The average precipitation for the State was by far the heaviest on record for the month. Conditions were unfavorable for preparing the soil for planting, and as a result little was accomplished along this line, except in some of the southern counties where oat seeding and truck gardening were in progress.—*W. S. Belden.*

Missouri.—Wheat was well protected by snow during the coldest weather except in a few of the northern and some of the extreme southern counties, and although it suffered some injury in localities from alternate thawing and freezing during the first part of the month, was generally reported in fair to good condition at the close. Practically all of the peach buds were killed by the low temperature of the 17th, except in a few of the extreme southern counties.—*A. E. Hackett.*

Montana.—The mean temperature for February was below the seasonal average in practically every part of the State, and the monthly range was unusually great. The range was covered with a sheet of crusted snow throughout the Milk River Valley to the east of Chinook, and in the Missouri River Valley in Dawson and Valley counties, and stock was suffering at the close of the month.—*Montrose W. Hayes.*

Nebraska.—The heavy snowfall of the month was very favorable to fall sown grain. The ground was covered with snow most of the time, protecting the grain from the low temperatures of the middle of the month, and the water from the melting snow will furnish sufficient moisture to place the ground in excellent condition to favor the growth of the grain when warm weather comes. Winter wheat continued in good condition. The ground being covered with snow has been unfavorable for stock interests in western counties, requiring an unusual amount of feed for the stock.—*G. A. Loveland.*

Nevada.—The weather throughout the month was unusually cold, with heavy snows on the 1st, 4th, and 8th. The valleys were covered with snow the first three weeks. In the mountain districts many sheep died from cold and starvation, the owners being unable to carry feed to them or drive them to the valleys on account of the deep snow.—*J. H. Smith.*

New England.—The month, though generally mild as to temperature, was considered stormy, with rapid and sudden weather changes. At the close of the month the ground in the southern portion was bare while in northern sections the depth of snow was less than the average for the season.—*J. W. Smith.*

New Jersey.—Winter grain and grass were well covered by heavy snow from the 16th to 26th. At the close of the month, although well protected during the severe cold spell, 17th to 23d, wheat and rye were below the average. Much young grass had been winter killed, and the fields looked very yellow. Orchard fruit trees have wintered well. The average depths of snowfall for the various districts were as follows: The Highlands and Kittatinny Valley, 8.6 inches; Red Sand Stone Plain, 10.8 inches; Southern Interior, 3.4 inches; Sea Coast, 4 inches. Some early peas were planted in the southern section.—*Edward W. McGann.*

New Mexico.—Unusually cold February, with much more snow than usual, especially in northeastern and central sections. Some slight loss

in stock on northern ranges, but the beneficial effect of the heavy snows far outbalanced the loss. Soil was in excellent condition.—*R. M. Hardinge.*

New York.—The ground was reported bare in some sections during the first of the month, injuring wheat and rye to some extent, and some tops were brown, but very little damage was mentioned. During the latter part of the month there was ample snow protection, and wheat and rye were in good condition.—*R. G. Allen.*

North Carolina.—On account of the excessive rainfall very little farm work could be accomplished during February, and conditions were not favorable for the winter cereals. The warmth and moisture during the first half of the month caused succulent growth of wheat, which was considerably injured by the subsequent severe freeze from the 17th to 20th. At the close of the month the appearance of winter wheat, oats, and rye was not so good, though the excellent stands were unimpaired. Toward part of the month trucking in the east made some progress and many tobacco beds were seeded.—*C. F. von Herrmann.*

North Dakota.—Some of the most severe cold weather for years prevailed during the month. The snowfall was less than usual in most sections.—*B. H. Bronson.*

Ohio.—Wheat was well protected by snow during the coldest weather, and received little if any injury from freezing and thawing; at the end of the month the plants were reported in good condition, but there was no snow on the ground. Stock was in good condition. No injury to peach buds was reported.—*J. Warren Smith.*

Oklahoma and Indian Territories.—Wheat was well protected by snow during cold period from 15th to 20th, and continues in good to fine condition; rye and volunteer oats were doing well. Stock was in fair condition, but suffered slight to serious loss during cold period. Fruit trees were uninjured. Farm work was delayed by wet, cold ground, and but small progress was made in seeding of oats and potatoes. The ground was full of moisture, and the outlook for crops was very promising.—*C. M. Strong.*

Oregon.—The month, although dry and sunshiny, was rather unfavorable for grain and forage plants; the nights were cold and frosty and the days were unusually warm. Early sown fall wheat maintained a good color and no complaint regarding the stand was made; winter seeded grain did not fare as well, especially that on low land, where the alternate freezing and thawing heaved the roots out of the soil, and some re-seeding will be necessary. There was a general shortage of pasture over the entire State at the close of the month.—*Edward A. Beals.*

Pennsylvania.—The mean temperature was higher than for any corresponding period since 1897 and the month was characterized by alternate and pronounced warm and cold spells. The average precipitation was the heaviest for any February since 1896; moderate amounts on the 1st to 4th, 8th and 9th, 11th and 12th; copious rains or heavy snow and sleet on the 15th, 16th, and 17th; heaviest rainfall of the winter on the 27th and 28th. Soil well protected by snow in most sections during the cold spell and so far as known grains and grass did not suffer by freezing.—*T. F. Townsend.*

Porto Rico.—The weather was ideal for cane cutting and sugar making, and this work was general; young canes needed more rain. Tobacco cutting progressed throughout the month and was nearly finished in some localities; this crop suffered from the dry weather and also from the tobacco flea. Coffee trees commenced to blossom during the last days of the month. Planting and cultivation of minor crops were retarded by the dry condition of the ground, especially in the southern and western districts. Pasturage was drying up and stock were suffering in consequence.—*E. C. Thompson.*

South Carolina.—The soil was too wet to permit much plowing or other farm work, which, in consequence, was backward. Fruit trees began to bloom early in the month in the southeastern portions, and buds were damaged by the freezing weather from the 17th to the 20th; truck was also injured slightly and growth checked. Wheat and oats continued promising. Seed beds for tobacco were prepared and seeded under unfavorable conditions.—*J. W. Bauer.*

South Dakota.—The temperature averaged below normal, with an unusually prolonged cold wave in the second decade. In the lower Missouri and several James Valley counties, the snowfall was considerably above the normal, but was deficient over most of the remainder of the State. Unmelted snow materially interfered with the grazing of live stock on large portions of the ranges, resulting in some losses and unusual consumption of stored feed. On the 28th, from 1 to 12 inches of snow covered the middle and eastern portions of the State.—*S. W. Glenn.*

Tennessee.—At the close of the month winter grains were in good condition generally, early sown wheat being well rooted and vigorous, with much better prospects than at this time last year; late sown was much damaged by cold from the 15th to 19th, but the snow on the ground from the 16th to 22d afforded some protection in places. Oats were badly winter killed. The rainfall was much above the average and the month was generally unfavorable for outdoor work.—*H. C. Bate.*

Texas.—Stormy, wintry weather characterized the month of February in all parts of the section. Marked fluctuations in temperature culminated in the severest cold wave of the winter from the 15th to 17th, which gave the first general freeze to all parts of the State and temperature below zero in the panhandle. Very heavy snowfalls in the panhandle and northwestern counties were recorded; at Amarillo the exces-

In the following table are given, for the various sections of the Climate and Crop Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting greatest and least monthly precipitation, and other data, as indicated by the several headings:

Summary of temperature and precipitation by sections, February, 1903.

Section.	Temperature—in degrees Fahrenheit.						Precipitation—in inches and hundredths.					
	Section average.	Departure from the normal.	Monthly extremes.				Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.			Station.	Amount.	Station.	Amount.
Alabama.....	48.4	+1.4	Bermuda.....	83	14	Newburg.....	0	17	Goodwater.....	16.66	Ozark.....	3.23
Arizona.....	44.0	-5.8	Aztec.....	84	24	Ft. Defiance.....	-18	4	Cochise.....	4.20	Buckeye.....	0.00
Arkansas.....	41.0	-0.4	Paragould.....	79	3	Flagstaff.....	-12	17	Prescott.....	11.49	Silver Springs.....	3.15
California.....	43.7	-5.5	Imperial.....	94	23	Pocahontas, Pond.....	-36	13	Mount St. Helena.....	7.96	5 stations.....	0.00
Colorado.....	17.3	-9.0	Blaine.....	63	11	Lay.....	-45	15	Ruby.....	4.00	Delta.....	0.13
Florida.....	62.7	+3.7	Huntington.....	90	16	De Funiak Springs.....	20	18	Molino.....	12.09	Flamingo.....	1.35
Georgia.....	49.7	+2.6	Bartow.....	86	15	Diamond.....	9	18	Clayton.....	14.41	Statesboro.....	3.10
Idaho.....	19.2	-7.7	Douglas, Millen.....	58	22	Chesterfield.....	-37	14	Silver City.....	2.21	Blackfoot.....	0.00
Illinois.....	27.9	+0.9	St. Marys.....	68	2	3 stations.....	-19	17	Raum.....	5.22	Antioch.....	0.60
Indiana.....	29.8	+1.9	Cobden.....	67	3	Logansport.....	-17	17	Marengo.....	7.87	Topeka.....	1.25
Iowa.....	19.8	-0.2	Mattoon.....	68	2	3 stations.....	-21	16-18	Danville.....	3.25	Galva.....	0.30
Kansas.....	27.4	-2.6	Vevay.....	56	2	3 stations.....	-22	17, 18	Garden City.....	4.41	Hanover.....	0.52
Kentucky.....	37.5	+2.8	Eldora.....	74	1	4 stations.....	-16	19	Alpha.....	10.50	Scott.....	5.12
Louisiana.....	52.2	-0.5	Medicine Lodge.....	75	13	Manchester.....	9	15-17	Lake Providence.....	16.02	Oxford.....	5.10
Maryland and Delaware.....	33.5	+4.6	Jackson, Pikeville.....	87	12	3 stations.....	-12	18	Bachmans Valley, Md.....	8.20	Chewsville, Md.....	2.74
Michigan.....	21.0	+2.1	Oxford.....	73	28	Frederick, Md.....	-39	16	Wasepi.....	4.12	Humboldt.....	0.10
Minnesota.....	10.6	-1.0	3 stations.....	53	2	Humboldt.....	-59	16	Willow River.....	2.56	St. Peter.....	T.
Mississippi.....	48.4	+0.1	Grape.....	47	22	Pokegama Falls.....	0	17	Kosciusko.....	16.29	West Point.....	6.06
Missouri.....	29.8	0.0	New Ulm.....	80	13-15	Ripley.....	25	17	New Madrid.....	7.31	Grant City.....	0.53
Montana.....	17.7	-2.5	Indianola, Laurel.....	74	2	Montreal.....	-45	16	Red Lodge.....	1.61	2 stations.....	T.
Nebraska.....	19.2	-4.7	Caruthersville.....	60	22	Ridgeland.....	-34	15	Hayes Center.....	3.83	Fort Robinson.....	0.60
Nevada.....	20.7	-12.1	Lamedeer.....	60	22	Agate.....	-32	13	Lewers Ranch.....	1.63	2 stations.....	T.
New England.....	25.7	+2.6	Agate.....	60	27	Van Buren, Me.....	-37	19	Kingston, R. I.....	7.04	Burlington, Vt.....	1.92
New Jersey.....	33.7	+3.6	Rioville.....	86	24	Wells.....	-32	13	Woodbine.....	6.60	Layton.....	3.74
New Mexico.....	30.1	-5.9	Berlin Mills, N. H.....	63	28	Fort Union.....	-21	15	Mountainair.....	5.39	2 stations.....	T.
New York.....	26.0	+3.5	Beverly.....	70	28	Axon.....	-22	18	Wappingers Falls.....	6.08	Haskinville.....	0.72
North Carolina.....	44.9	+2.2	Carlsbad.....	79	1	Linville.....	-3	18	Highlands.....	15.93	Carriuck Inlet.....	2.56
North Dakota.....	3.1	-3.5	West Berne.....	65	28	Dunseith.....	-49	16	Fullerton.....	1.38	5 stations.....	T.
Ohio.....	29.9	+3.1	Wilmington.....	76	14	Milligan.....	-20	19	Waverly.....	7.75	Bucyrus.....	2.45
Oklahoma and Indian Territories.....	35.7	-2.1	Fort Yates.....	46	26	Kenton.....	-17	16	Hartshorne.....	7.12	Newkirk.....	1.53
Oregon.....	34.1	-3.6	3 stations.....	69	2	Pine.....	-24	13	Glenora.....	8.50	Arlington.....	0.00
Pennsylvania.....	30.5	+2.8	Goodwater.....	77	2	Lawrenceville.....	-17	17	York.....	6.13	Warren.....	1.80
Porto Rico.....	74.5	-0.3	Gardiner.....	71	28	Towanda.....	-17	18	Humacao.....	3.67	2 stations.....	T.
South Carolina.....	49.0	+3.0	California.....	68	2	Adjuntas.....	-48	13	Clemson College.....	12.48	Charleston.....	2.07
South Dakota.....	12.0	-3.8	Coatesville, Lebanon.....	95	17	Barksdale.....	-11	18	Yankton.....	2.58	Grand River School.....	0.01
Tennessee.....	41.4	+2.3	Manati.....	81	14-16	Aberdeen.....	-39	17	Decatur.....	15.11	Center Point.....	3.87
Texas.....	47.3	-2.7	3 stations.....	55	22	Rugby.....	-11	19	San Marcos.....	10.31	Fort Stockton.....	0.20
Utah.....	16.6	-12.7	Cherry Creek.....	76	15	Amarillo.....	-3	16	Frisco.....	1.66	2 stations.....	0.00
Virginia.....	39.8	+3.8	Newport.....	80	13	Henefer.....	-39	14, 15	Speers Ferry.....	8.18	Cape Henry.....	2.46
Washington.....	32.7	-3.2	Port Ringgold.....	67	24	Lincoln.....	-13	18	South Bend.....	6.78	Pullman.....	T.
West Virginia.....	35.3	+4.3	St. George.....	78	4	Ryan.....	-19	19	Chapel.....	9.59	Old Fields.....	2.58
Wisconsin.....	17.3	+0.8	Stevens City.....	63	20	Grantsburg.....	-40	16	Appleton.....	2.27	Downing.....	0.05
Wyoming.....	13.5	-7.9	Ilwaco.....	74	2	Border.....	-51	14	Cheyenne.....	1.79	Irma.....	0.10
			Cuba.....	57	12							
			Prairie du Chien.....	56	19							
			Irma.....	56	19							

sive amount of 28.7 inches (unmelted) was reported. Farming operations practically suspended in many parts of the State, and little land from the severe freezing weather which prevailed from the 16th to the 23d. Plowing was generally backward, but had been begun in several southern counties, and a few tobacco beds were sown. Range stock suffered during the cold, snowy weather, but fed stock was in good condition. Rough feed was becoming scarce in some counties, but it will probably last through the winter. Peach buds which had swollen were probably killed.—*E. C. Vose.*

Utah.—The month was not only the coldest February, but one of the coldest months on record for the State. Fields were generally well covered with snow throughout the month, and it was therefore not probable that any damage was done to fall grain by the low temperatures. The fruit crop was also thought to have passed through the month without damage. The small amount of feed which remained on the ranges was covered with snow, and reports indicated that a large number of cattle and sheep perished from starvation and exposure.—*L. H. Murdoch.*

Virginia.—The temperature of the month was above normal; the precipitation, nearly all of which came as rain, was in excess. On the whole, winter wheat and oats made satisfactory progress, though the wet condition of the soil caused some damage, and winter killing occurred, locally, during the coldest weather of the month. Some preparation of tobacco plant beds was made, though this and other outdoor work was hampered by unfavorable weather.—*Edward A. Evans.*

Washington.—Although the month was open, and there was an abundance of warm sunshine, winter wheat did not grow much on account of cold and frosty nights. Alternate thawing and freezing was thought by many to have caused some injury to wheat, but although it had not grown much it was in fairly good condition. Snow melted off before the end of the month, leaving the ground bare and wheat unprotected. Fruit buds were thought to be uninjured, although somewhat unduly developed.—*G. N. Salisbury.*

West Virginia.—Wheat, rye, oats, and grass were in better condition than usual at the close of February, being protected by a heavy snowfall from the severe freezing weather which prevailed from the 16th to the 23d. Plowing was generally backward, but had been begun in several southern counties, and a few tobacco beds were sown. Range stock suffered during the cold, snowy weather, but fed stock was in good condition. Rough feed was becoming scarce in some counties, but it will probably last through the winter. Peach buds which had swollen were probably killed.—*E. C. Vose.*

Wisconsin.—Conditions during the month generally favorable. Ample snowfall to afford protection to growing crops during the cold period from the 14th to the 24th, and sufficient precipitation, with the exception of small areas in the northern counties, to meet requirements of soil and winter grains and grasses. Special reports indicated generally satisfactory condition of winter crops. Precipitation somewhat below normal, but fairly well distributed.—*J. W. Shaeffer.*

Wyoming.—The month was a very unfavorable one for stock depending on range feed, owing to extreme cold and much of the range being covered with a crust of hard snow; the losses thus far have probably not exceeded the normal. The stock of snow in the mountains over the southern half of the State was such as to insure a good supply of water for irrigation next summer; the northern half of the State did not have as good a snowfall.—*W. S. Palmer.*

SNOWFALL AND WATER SUPPLY IN THE ROCKY MOUNTAIN REGION.

The following extracts are taken from the snow bulletins for February, 1903, prepared by the Section Directors of Climate and Crop sections in the Rocky Mountain region:

Arizona.—In the mountains snow lies on the ground to depths varying from one inch to several feet, giving promise of an adequate supply of

irrigation water for the coming crop season. Rain and melting snow during the winter have caused the soil in the regions which supply water for irrigation purposes to become generally well saturated with water, which increases the favorableness of the prospects. Springs in the mountain region are increasing in the amount of running water.

Colorado.—There has been a general and material improvement in the outlook for late irrigation. Over a comparatively small area in the center of the State, in Lake, Summit, Eagle, and the northern part of Gunnison, where the Gunnison, Grand, and Arkansas rise, the totals were considerably less than normal, but in general other parts of the mountain region appear to have had the normal amount or an excess. Exceptionally low temperatures have been a feature, and even on the sunny slopes there has been but little melting. The action of the winds will also be a factor in conserving the moisture, for the bulk of the current fall has been swept into huge drifts in the timber, gulches, etc., where it is likely to remain hard packed and practically solid ice until after later snowfalls have been melted.

Idaho.—February has contributed little to the supply of snow, the month having been deficient in precipitation over the entire State. However, while great extremes of cold have not been reached, the temperature has been uniformly lower than the average, so that while there has been a decrease in the depth of snow in the valleys the amount at higher elevations averages about the same as at the close of January. What little melting has taken place has only served to settle and pack the snow rather than to diminish its mass, so that in most sections the mountain gulches are well filled with hard, icy snow. In some sections high winds have formed drifts of great depths, which will further contribute to the uniformity of the waterflow.

Montana.—In numerous sections of Montana, especially to the west of the mountains, February was a cold month. The snowfall was deficient

over the greater portion of the State and general conditions have not changed materially since January 31. There is, however, a good supply of hard packed or solid snow that fell during the earlier part of the winter at the heads of most of the streams, and with few exceptions an ample supply of water would seem to be assured.

Nevada.—High winds drifted vast quantities of snow into the canyons and gulches where it is packed solid and in many localities nearly a hundred feet deep. The outlook for an abundance of water during the coming season is the best in many years.

New Mexico.—Reports from all sections of the Territory show that February brought more moisture than any February for many years past. The depth of snow lying on the ground at the end of the month ranged from 6 feet in the northern mountains to about a foot on the average in the Black Range country. The northeastern section of the Territory, which suffered so greatly from the protracted drought of last year, has had deep snows, covering all the plains to a depth of from 8 inches to 2 feet, and in the mountains of Union County to a great depth. Reports indicate that the snow is well packed in the ravines, thus insuring a steady supply. The streams are now carrying a good supply, and there is every prospect for an abundance of water for several months to come.

Utah.—The month was one of the coldest on record, and there was little or no loss of snow by melting. The snow continued to drift and pack nicely. As stated in the January bulletin, all sections of the State will have an abundant supply of water for irrigation throughout the whole of the coming crop season.

Wyoming.—Cold weather and a snowfall much in excess of the February normal was general over nearly every section of the State during the month.

SPECIAL CONTRIBUTIONS.

HAWAIIAN CLIMATOLOGICAL DATA.

By CURTIS J. LYONS, Territorial Meteorologist.

GENERAL SUMMARY FOR FEBRUARY, 1903.

Honolulu.—Temperature mean for the month, 67.3°; normal, 70.6°; average daily maximum, 73.2°; average daily minimum, 61.3°; mean daily range, 11.9°; greatest daily range, 20.0°; least daily range, 6°; highest temperature, 77°; lowest, 53°. The month was colder than any month on record—25 years.

Barometer average, 30.003; normal, 29.958; highest, 30.21, 16th; lowest, 29.66, 19th; greatest 24-hour change, that is, from any given hour on one day to the same hour on the next, 0.30, 18–19th; lows passed this point on the 10th and 19th; highs on the 6th and 16th.

Relative humidity average, 71.4 per cent; normal, 76.0 per cent; mean dew-point, 57.0°; normal, 62.5°; mean absolute moisture, 5.24 grains per cubic foot; normal, 6.24 grains.

Dew-point lowest on record. Low periods indicating also passage of cold wave, 10th to 14th, and 23d. Dew on grass, 8 mornings.

Rainfall, 5.86 inches; normal, 5.48; rain-record days, 12; normal, 15; greatest rainfall in one day, 2.14, on the 20th; total at Luakaha, 7.98; normal, 14.07; at Kapiolani Park, 4.44; normal, 4.89.

The artesian well level rose during the month from 35.06 to 35.25 feet above mean sea level. February 28, 1902, it stood at 33.80. The average daily mean sea level for the month was 9.66, the assumed annual mean being 10.00 feet above datum. For February, 1902, it was 9.89.

Trade wind days, 17, (5 NNE.); normal, 12; average force of wind during daylight, 2.7, Beaufort scale. Average cloudiness, tenths of sky, 4.7; normal, 4.9.

Approximate percentages of district rainfall as compared with normal; South Hilo, 82 per cent; North Hilo, 130; Hamakua, 82; Kohala, 85; Waimea, 80; Kona, 65; Kau, 60; Puna, 80; Maui, 100; Oahu, Honolulu, 100; Upper Nuuanu and Koolau, 60; Kauai, 42.

The heaviest rainfall reported for the month was at Puuhua, Hilo, 19.36. Heaviest 24-hour rainfall, 4.86, at Laupahoehoe, 23d.

Ewa, 50 feet elevation, reports 51° minimum temperature on the 10th; Waimea and Waiakoa, 44° lowest temperature; Hilo, 54°.

Rainfall data for February, 1903.

Stations.	Elevation.	Amount.	Stations.	Elevation.	Amount.
HAWAII.			OAHU.		
Hilo, e. and ne.	Feet.	Inches.	Punahou (W. B.), sw.	Feet.	Inches.
Waikae	50	9.18	Kulaokahua (Castle), sw.	50	4.23
Hilo (town)	100	8.46	Makiki Reservoir	120	4.81
Kaunama	1,250	9.02	U. S. Naval Station, sw.	6	2.45
Pepeskee	100	8.23	Kapiolani Park, sw.	10	4.44
Hakalau	200	10.17	College Hills	175	5.58
Honohina	300	13.21	Manoa (Woodlawn Dairy), c.	285	7.77
Puuhua	1,050	19.36	Manoa (Rhodes Gardens)	360	9.42
Laupahoehoe	500	11.95	School street (Bishop), sw.		
Ookala	400	10.98	Insane Asylum, sw.	30	5.08
HAMAKUA, ne.			Kamehameha School	75	
Kukui	250	8.13	Kalihi-Uka, sw.	485	7.77
Pauilo	300	6.55	Nuuanu (W. W. Hall), sw.	50	5.18
Pauhanu	300	5.04	Nuuanu (Wylie street)	250	
Honokaa (Mill)	425	5.24	Nuuanu (Elec. Station), sw.	405	5.23
Honokaa (Meinicke)	1,100		Nuuanu (Luakaha), c.	850	7.98
Kukuihaele	700	3.99	U. S. Experiment Station	350	5.69
KOHALA, n.			Laniakaa (Nahuina)	1,150	8.32
Niuli	200	3.53	Tantalus Heights	1,360	10.54
Kohala (Mission)	521	3.71	Waimanalo, ne.	300	2.84
Kohala (Sugar Co.)	270	3.35	Maunawili, ne.	300	5.02
Hawi, Mill	700	4.34	Kaneohe	100	3.63
Puakea Ranch	600	3.96	Ahuimanu, ne.	350	5.27
Puuhue Ranch	1,847	4.75	Kahuku, n.	25	2.73
Waimea	2,720	3.68	Waialua	37	
KONA, w.			Wahiawa	900	
Holualoa	1,350	2.16	Ewa Plantation, s.	60	1.39
Kealahakua	1,580	1.76	U. S. Magnetic Station	45	1.31
Napoopoo	25	1.85	Waipahu	200	1.59
Hoopulua	1,650		Monnialua	15	6.12
KAU, so.			KAUAI.		
Kahuku Ranch	1,680	1.94	Lihue (Grove Farm), e.	200	2.07
Honoupo	15	1.00	Lihue (Molokoa), e.	300	1.80
Naalehu	650	1.31	Lihue (Kukana), e.	1,000	4.14
Hilea	310	2.20	Kealia, e.	15	1.29
Pahala	850		Kilauea, ne.	325	2.36
Moaula			Hanalei, n.	10	4.78
Volcano House	4,000		Waioli	10	4.67
PUNA, e.			Haena	15	4.56
Olaa, Mountain View (Russel)	1,600	10.57	Waiawa	32	0.86
Kapoho	110	2.28	Eleele	150	0.89
Pahoa	600	10.16	Wahiawa (Mountain)	3,000	7.60
MAUI.			McBryde (Residence)	850	3.24
Lahaina	40	3.58	Lawai (Gov. Road)	450	3.46
Waipae Ranch	700	1.99	Lawai, w.	225	2.08
Kaupo (Mokulau), s.	285	6.63	Lawai, e.	800	3.16
Kipahulu, s.	308		Koloa	100	2.76
Nahiku, ne.			Delayed January reports.		
Nahiku	1,600	17.80	Kaunama		4.03
Haiku, n.	700	6.88	Niuli		4.10
Kula (Erehwon), n.	4,500	5.94	Holualoa		3.17
Kula (Waiakoa), n.	2,700	3.50	Nahiku	1,600	25.40
Puomalei, n.	1,400		Haleakala Ranch		14.21
Paia	180	7.32			
Haleakala Ranch	2,000	11.79			
Wailuku, ne.	250	5.58			

NOTE.—The letters n, s, e, w, and c show the exposure of the station relative to the winds.

OBSERVATIONS AT HONOLULU.

The station is at 21° 18' N., 157° 50' W. It is the Hawaiian Weather Bureau station Punahou. (See fig. 2, No. 1, in the MONTHLY WEATHER REVIEW for July, 1902, page 365.) Hawaiian standard time is 10^h 30^m slow of Greenwich time. Honolulu local mean time is 10^h 31^m slow of Greenwich.

The pressure is corrected for temperature and reduced to sea level, and the gravity correction, -0.06, has been applied.

The average direction and force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force, or amounts of cloudiness, connected by a dash, indicate change from one to the other.

The rainfall for twenty-four hours is measured at 9 a. m. local, or 7.31 p. m., Greenwich time, on the respective dates.

The rain gauge, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 43 feet and the barometer 50 feet above sea level.

Meteorological Observations at Honolulu, February, 1903.

Date.	Pressure at sea level.		Temperature.		During twenty-four hours preceding 1 p. m. Greenwich time, or 1:30 a. m. Honolulu time.										Total rainfall at 9 a. m., local time.
					Temperature.		Means.		Wind.		Average cloudiness.	Sea-level pressures.			
	Dry bulb.	Wet bulb.	Maximum.	Minimum.	Dew-point.	Relative humidity.	Prevailing direction.	Force.	Maximum.	Minimum.					
1	30.11	69	62.5	74	69	58.7	66	ene.	5	5	30.18	30.08	0.01		
2	30.12	70	63.5	74	67	59.5	68	ne.	4-5	5	30.16	30.10	0.00		
3	30.05	70	62.5	75	69	59.5	66	ne.	4-5	3-7	30.16	30.04	0.00		
4	30.03	68	64.5	75	69	60.0	70	ne.	4-5	8	30.10	30.01	1.35		
5	30.05	70	64	75	66	61.5	73	ne.	3-5	8-4	30.10	30.01	0.40		
6	30.14	70	63.5	75	67	60.5	73	ne.	5	6	30.19	30.05	0.45		
7	30.14	69	64.5	74	65	59.7	70	ne.	5	5	30.19	30.09	0.25		
8	30.07	71	66	74	67	63.7	78	ne.	5	5	30.16	30.05	0.10		
9	29.99	63	62.3	76	68	64.5	80	ne.	3-0	4-1	30.11	29.99	0.00		
10	29.93	56	55	77	62	64.0	80	ws-w.	0-3	0	30.00	29.87	0.00		
11	29.88	55	53.5	72	56	52.3	72	n.	0	0-1	29.94	29.81	0.00		
12	29.90	54	53	73	53	55.0	79	n-w.	0-2	2	29.95	29.85	0.00		
13	30.09	64	61.5	73	53	55.7	79	w.	2-0	2	30.02	29.93	0.00		
14	30.06	66	57.5	74	61	58.3	72	w-n.	0-4	10-1	30.06	29.96	0.00		
15	30.10	65	57.5	72	65	49.3	65	nne.	4	10-4	30.14	30.05	0.00		
16	30.16	68	58.5	72	63	54.0	64	ne.	3-4	4	30.19	30.11	0.00		
17	30.14	65	61	74	65	54.7	62	ne.	3	5	30.21	30.14	0.00		
18	30.06	61	57	72	61	56.7	67	ne.	3	6	30.19	30.07	0.00		
19	29.86	61	56.5	74	59	50.7	62	sw-n.	1-0	9-0	30.08	29.87	0.00		
20	29.66	61	58	69	57	56.5	81	sw-w.	3-0	10-3	29.87	29.66	2.14		
21	29.85	68	63	70	54	59.5	84	nne.	4	9-6	29.88	29.66	0.60		
22	29.90	66	64	73	64	60.7	76	ne.	4	8	29.96	29.84	0.50		
23	29.92	59	53.5	73	63	61.0	82	ne-n.	3-0	9-1	29.95	29.86	0.01		
24	29.92	56	54	70	54	49.0	61	nw.	2-4	5	29.95	29.85	0.02		
25	29.99	64	58	72	56	53.3	73	nw-n.	2-0	4	30.02	29.91	0.00		
26	29.95	61	59	72	56	55.7	71	n.	2	5	30.02	29.92	0.00		
27	30.00	63	59.5	73	61	54.3	68	nne.	3-0	1	30.05	29.93	0.00		
28	30.04	62	56.5	73	57	54.5	70	ne.	3	10-3	30.07	29.99	0.00		
29															
30															
31															
Sums.														5.86	
Means.	30.001	64.1	59.6	73.2	61.3	57.0	71.4		2.7	4.7	30.064	29.954			
Departure.	+0.03					-5.5	-5.0				-0.2			+0.38	

Mean temperature for February, 1903, (6 + 2 + 9) ÷ 3 = 67.3; normal is 70.6. Mean pressure for February, 1903, (9 + 3) ÷ 2 = 30.003; normal is 29.958.

*This pressure is as recorded at 1 p. m., Greenwich time. †These temperatures are observed at 6 a. m., local, or 4.31 p. m., Greenwich time. ‡These values are the means of (6 + 9 + 2 + 9) ÷ 4. § Beaufort scale.

Maximum thermometer set at 9 p. m. and minimum at 2 p. m., local time.

Mean temperature table.

Stations.	Elevation.	Mean max.	Mean min.	Cor. av'ge.
	Feet.	°	°	°
Pepeskeo	100	74.0	63.9	68.3
Waimea	2,730	69.2	52.3	60.0
Kohala	521	73.6	61.5	67.0
Nahiku	1,600	67.5	59.0	62.5
Waiakea	2,700	70.0	50.8	60.1
Ewa Mill	59	76.5	60.0	67.6
United States Magnetic Station	50	76.4	59.7	67.3
United States Experimental Station	350	73.8	62.2	67.5
W. R. Castle	60			66.8
Tantalus	1,725			
Hilo	40	76.6	62.0	68.6
Waikiki	15	73.1	63.8	68.0

Kohala, Bond, dew point, 58.4°; relative humidity, 73 per cent; Ewa Mill, 56° and 65; Magnetic Station, 57° and 71, same as Punahou.

As stated before, the month was the coldest on record, the dew-point also being the lowest. The marked disturbances of the month were about the 10th and 20th. Heavy surf, 1st-7th, 11th, and 21st. Snow on the 19th, 20th, and 23d. The first

fell as low down on the mountains, including Hualalai in Kona, as yet known, the previous recorded snowfalls on Mount Hualalai being in 1892 and 1863. Seven thousand feet elevation is about the lowest limit of snowfall on the Hawaiian mountains.

Electric storms on the 19th and 20th on Maui and Hawaii. Earthquakes, Hilo, 9th, 11:23 a. m., and 21st; Waimea, 4th, 10 p. m.; Kohala, 4th, 12:20 a. m.

The total rainfall at Nahiku, Maui, at 1600 feet elevation, for the twelve months from March 1, 1902, to February 28, 1903, 429.48 inches.

CLIMATOLOGY OF COSTA RICA.

Communicated by H. PITTIER, Director, Physical Geographic Institute.

[For tables see the last page of this REVIEW preceding the charts.]

Notes on the weather.—On the Pacific slope the weather was quite normal for the season; i. e., hot, dry, and windy. For San José pressure and temperature were slightly above the normals, while the hours of sunshine show a large excess. On the Atlantic slope rain was rather scarce and the coast stations report several squalls with a stormy sea.

Earthquakes in San José.—February 1, 9^h 15^m a. m., light shock E-W, intensity I, duration 3 seconds. February 2, 12^h 33^m p. m., light shock N-S, intensity II, duration 5 seconds. February 3, 6^h 20^m a. m., rather strong and well-felt shock N-S, intensity III, duration 4 seconds. February 10, 6^h 07^m a. m., strong shock E-W, intensity III, duration 10 seconds. February 11, 4^h 49^m a. m., slight shock E-W, intensity II, duration 4 seconds. February 22, 3^h 05^m p. m., strong shock E-W, intensity III, duration 8 seconds. February 24, 8^h 22^m p. m., light shock E-W, intensity II, duration 4 seconds; 10^h 12^m p. m., slight shock E-W, intensity III, duration 6 second. Another shock, strong and dilated, is reported from Cachi and Paraiso, having been felt same day, 24th, at about 4 a. m. February 25, 6^h 06^m a. m., well-felt shock E-W, intensity III, duration 6 seconds. February 28, 4^h 09^m a. m., dilated tremors E-W, intensity III, duration 38 seconds; generally felt, frightening people. The same earthquake is officially reported from San Isidro de Alajuela.

THE TEMPERATURE AND RAINFALL DEPARTURES AT HAWAII, AS DUPLICATED IN NEW ENGLAND SIXTY DAYS LATER.

By ALTON D. ELMER, Northfield, Mass., dated February 11, 1903.

When the MONTHLY WEATHER REVIEW began publishing Curtis J. Lyons's Hawaiian observations it was said to be done for the benefit of those who wished to study for long-range seasonal predictions. I, therefore, inclose a copy (unverified for clerical errors) of some comparisons which I have just made, only extending them until I detected a correlation between the Honolulu monthly temperatures and those of New England two months later.

Table 1 shows that changes in the departures from monthly normals of rainfall in Honolulu are followed by corresponding changes in New England sixty days later, in a majority of cases, and the same holds good for the temperature departures.

Attention is called to the fact that the 60-day period, not only for precipitation but also for temperature, is much more marked as the records progress, thus confirming a suspicion that the whole difficulty in the earlier records was the want of good normals.

During 1902, rising or falling monthly temperatures at Hawaii were followed by increased or decreased precipitation in New England two months later, with the exception of but one and one-half months. The year 1902 was likewise remarkable in New England for having increased temperature accompany increased precipitation and decreased temperature accompany decreased precipitation every month but one. This is explanatory of the cold summer, corrected by a warm spring and a

warm fall. Carrying comparisons back to 1898 shows that predictions of rainfall and temperature in New England can sometimes be made from the preceding temperature of Honolulu. But it is interesting to observe that when this 60-day rule does not apply, the temperature at Honolulu is followed sixty days later by a similar temperature in New England 14 times out of 18 in the four years or 78 per cent. Excluding four months of comparisons, affected by uncertain normals, 31 out of 44 or 70 per cent of months of observed temperature at Honolulu were followed two months later by similar changes in New England.

TABLE 1.—Departures from monthly normals in Honolulu.

Year and month.	Rainfall departures.		Temperature departures.	
	Honolulu.	New England.	Honolulu.	New England.
	Inches.	Inches.	° F.	° F.
1898.				
May	—	+ 0.49	—	— 0.9
June	+ 1.34	— 0.20	— 1.5	— 0.7
July	—	+ 0.52	—	+ 1.2
August	—	+ 1.62	—	+ 2.7
September	—	— 0.36	— 0.1	+ 2.6
October	—	+ 2.78	— 0.3	+ 2.6
November	— 4.20	+ 1.82	+ 1.1	+ 0.9
December	—	— 1.08	— 1.0	— 1.3
1899.				
January	— 2.05	— 0.29	+ 0.4	+ 0.6
February	— 1.00	+ 0.30	+ 1.6	— 2.0
March	+ 0.78	+ 2.91	+ 0.5	— 1.1
April	— 1.94	— 1.35	— 0.1	+ 1.0
May	— 0.80	— 2.01	0.0	+ 0.4
June	— 0.40	0.00	— 0.8	+ 1.5
July	— 1.60	0.00	— 0.3	0.0
August	— 0.50	— 2.26	— 0.3	+ 0.3
September	— 1.35	+ 1.40	— 0.2	— 1.4
October	+ 1.56	— 1.67	— 0.6	+ 3.1
November	— 4.85	— 1.76	— 0.3	0.0
December	— 2.91	— 1.41	+ 0.6	+ 2.7
1900.				
January	— 2.46	+ 0.71	+ 0.4	+ 2.1
February	— 4.86	+ 3.69	— 0.1	+ 0.2
March	— 1.60	+ 1.65	+ 1.2	— 3.2
April	+ 2.24	— 1.19	0.0	— 1.2
May	— 1.40	+ 0.24	+ 0.7	— 2.2
June	— 0.72	— 0.14	+ 1.7	+ 0.8
July	+ 0.79	— 1.64	+ 1.3	+ 1.7
August	—	— 1.42	+ 1.3	+ 2.0
September	— 0.50	— 1.30	+ 0.9	+ 2.3
October	+ 4.42	0.00	+ 0.6	+ 5.8
November	+ 5.78	+ 1.57	+ 0.3	+ 2.9
December	— 3.00	— 1.24	+ 0.1	— 1.7
1901.				
January	— 0.10	— 1.64	+ 1.2	0.0
February	+ 2.00	— 2.48	— 1.7	— 5.1
March	+ 0.82	+ 1.91	+ 1.0	+ 0.5
April	+ 0.30	+ 3.85	+ 0.2	— 1.0
May	+ 0.23	+ 2.03	+ 0.6	— 0.7
June	— 0.10	— 0.91	+ 1.5	+ 0.9
July	— 0.27	— 0.43	+ 0.5	+ 2.6
August	— 1.09	+ 1.66	+ 1.1	+ 1.7
September	— 1.19	— 0.97	— 0.3	+ 1.3
October	+ 1.68	— 0.64	— 0.5	+ 1.7
November	+ 1.68	— 1.72	— 0.5	— 4.4
December	+ 6.06	+ 4.08	+ 0.1	— 0.8
1902.				
January	— 2.80	— 1.48	+ 0.7	— 0.6
February	— 4.45	+ 0.33	— 0.9	+ 0.7
March	+ 7.96	+ 2.35	0.0	+ 7.8
April	—	+ 3.66	— 1.0	+ 2.0
May	— 1.34	— 1.17	— 0.8	— 1.2
June	— 0.33	— 1.42	— 0.2	— 3.6
July	+ 1.07	— 0.77	+ 0.5	— 2.5
August	— 0.24	— 0.62	+ 0.8	— 2.3
September	+ 0.29	+ 2.15	— 0.1	+ 1.3
October	— 0.17	+ 1.35	— 0.6	+ 1.3
November	+ 4.65	— 0.93	— 0.5	+ 4.8
December	—	—	—	—

It would seem, therefore, that there is a certain interval between Hawaii and New England by which monthly climatological predictions may be approximated to a considerable degree of accuracy.

NOTE.—The above table is as given by Mr. Elmer without being revised by the Editor. If the rainfall had been expressed as percentages of the normal annual amounts and the temperatures had been expressed as percentages of the normal annual fall at the respective stations, the comparison would have been even more interesting. Any improvement or change in the adopted monthly normals will change the positive and negative signs, and also the above rule as given by Mr. Elmer.

His conclusions, therefore, may not be confirmed by further investigation, but some definite geographic correlation of value may result.—Ed.

SOME HIGH WIND RECORDS ON THE PACIFIC COAST.

By Prof. ALEXANDER G. MCADIE and Mr. W. W. THOMAS, Observer, United States Weather Bureau, dated May 27, 1902.

At the beginning of the year 1902 a new Weather Bureau station at Point Reyes Light was completed. The station is located in latitude $38^{\circ} 12'$ north, longitude $122^{\circ} 51'$ west of Greenwich. The station at this point was originally in rooms of the United States Light-House Building, upper southwest corner, and the records go back to October 9, 1888. The first observation in the present office was on January 17, 1902. The elevation of the new building is 490 feet above sea level. The height of the anemometer cups above the ground is 30 feet. On February 23, 24, and 25, 1902, a severe southeast disturbance prevailed along the coast of California. This was the first pronounced disturbance to which the new station had been subjected. The following extracts from the Daily Journal at Point Reyes Light by the Observer, Mr. W. W. Thomas, tell the story of the weather conditions at that time:

February 23, 1902.—A southeast storm began during the night with light rain and a 70-mile wind; the storm continued throughout the day showing no abatement at nightfall. A maximum of 80 miles from the southeast was recorded at 1:30 p. m., and this velocity was reached frequently during the afternoon. Order to hoist southeast storm warnings received 12 noon. Line down since 12 noon. No communication east.

February 25, 1902.—The day opened with light rain and a terrific southeast storm in progress; wind increased rapidly to 90 miles an hour at 10:15 a. m. and continued at that velocity until after 12 noon, very frequently reaching velocities of 98 to 100 miles an hour. A maximum of 98 miles during five consecutive minutes occurred 11:15 a. m., at which time an extreme velocity of 103 miles was recorded—a mile in 35 seconds. The wind began to veer to the west and to lose its force soon after noon; clearing conditions began and at 2 p. m. the weather was practically clear, with a fresh southwest wind. About 3 p. m. the clouds began to increase rapidly and during the evening threatening weather prevailed with brisk southwest wind.

Distant lightning was observed in the northwest between 11 and 12 p. m., and later information showed that distant thunder and lightning occurred in the northwest frequently throughout the night.

Since the passage of this storm the weather has reached a normal condition.

During all this terrific wind the anemometer worked magnificently and none of the instruments were damaged in the least.

On March 1 another severe southeast disturbance prevailed off this section of the Pacific coast. At San Francisco the wind changed from southeast at 9 p. m., seventy-fifth meridian time, blowing from the south for about 28 minutes and then from the southwest, reaching a maximum velocity a little after 10 p. m. of 60 miles and an extreme velocity at 10:12 p. m. of 75 miles. At Point Reyes Light the maximum velocity occurred at 9:45 p. m., when 10 miles were recorded in a trifle over five minutes. The observer states in a letter "that for a half hour prior to this time he checked off the 10-mile spaces as they occurred, timing the miles with his watch. One mile was completed in slightly less than thirty seconds; and for five minutes, including the time of the extreme velocity, the miles averaged a small fraction less than thirty-three and one-half seconds." This is at the rate of 107 miles per hour. The following brief report of the storm was written by the observer, Mr. W. W. Thomas:

The day opened with cloudy, threatening weather and light wind varying in direction from southeast to northeast. Light rain began at 7:45 a. m., local time; wind continued light to fresh, northeast to southeast until noon, when it began blowing steadily from the southeast and to increase in force to about 45 miles an hour. At 3:30 p. m. it increased suddenly to a little more than 70 miles an hour. Light rain ended at 5:35 p. m. and at 5:55 p. m. a rainbow was observed. About 5:30 p. m. the wind began to veer to the westward and to increase rapidly in force. At 6:45 p. m. a maximum of 108 miles was recorded from southwest. Wind continued to veer to west and northwest, still continuing at about 100 miles an hour until 9 p. m., local time.

Our flagstaff (wooden) blew down at 6:45 p. m. and the receiver of the rain gage blew away and has not been found.



FIG. 1.—Weather Bureau building at Point Reyes Light and the old flag staff, blown down March 1, 1902, after standing for several years.

The flagstaff blown down is shown in the accompanying photograph (fig. 1) made by Professor McAdie on December 28, 1901, just before the building was ready for occupancy. It should be stated that this flagstaff had stood for several years, being used for signaling purposes, and was, so far as one could judge, well braced and generally in good condition.

From May 15 to 20, 1902, the daily weather maps show the existence of a marked depression over the Mexican boundary and the valley of the Colorado. On Saturday, May 17, the southern depression, merging into an extensive trough overlying the entire Rocky Mountain region, was followed on the Pacific coast by an area of high pressure. While the readings were neither very low nor yet very high, there appears to have been an extensive air motion, an unusually large number of stations reporting maximum velocities. On the California coast steady and extremely high northwest winds prevailed for a period of not less than seventy-two hours. At Point Reyes Light for forty-eight hours ending midnight, May 18, the average velocity of the wind was 72 miles; for the twenty-four hours ending midnight, May 18, the average velocity was 78 miles; for twelve hours ending midnight, May 18, the average velocity was 84 miles; for six hours ending midnight, May 18, the average velocity was 88 miles. The greatest number of miles recorded in any one hour was 102, from 8 to 9 p. m., seventy-fifth meridian time, May 18. The maximum velocity for the storm was 110 miles, at 8:50 p. m. of the 18th, and the extreme velocity 120 miles, at 8:38 p. m.

This record is so remarkable for its length, the high velocities involved, and the general character of the air motion that a photographic copy has been made, accompanied by a partial enlargement, 3.3 times the original, of the portion between 8 and 9 p. m., when the extreme velocity was recorded. Four thousand seven hundred and one miles of wind are legibly recorded, and the record is complete, except from 9:19 to 9:36 p. m., during which time the observer put a new set of cups on the anemometer to replace a set that had become loosened from the axis and carried away at 9:19 p. m., May 18, the actual number of miles for the hour preceding being 91.

It also appears that between 8 and 9 p. m. on May 19 we have an actual record of 102 miles per hour. According to the tables furnished on page 16 of Circular D of the Instrument Division, the corrected velocity corresponding to this observed velocity would be about 77 miles.

It is not known to the writer how this record compares with those made at other points. He has found, however, a record in the MONTHLY WEATHER REVIEW for January, 1886, page 15, which, referring to the storm at San Francisco on January 22 giving a maximum velocity of 42 miles, states that the storm was said to have given the heaviest wind in twenty-five years. At Cape Mendocino, Cal., the writer finds, by reference to the forecast charts at San Francisco, a record of 108 miles, from the southeast, on January 22, 1886, at 7 a. m. There was also recorded a maximum velocity of 144 miles, from the southeast, at Cape Mendocino on January 20, 1886. The original wind sheet, if it be in existence, is at Washington, D. C., and it might be interesting to compare that record with the present one. In a table of the average velocity at Weather Bureau stations and the highest velocities for a 5-minute period, the Chief of the Weather Bureau gives 104 miles at Fort Canby, Wash.; at Hatteras, N. C., 105 miles; at Galveston, Tex., 100 miles; at Kittyhawk, N. C., 100 miles. The highest velocity recorded at San Francisco is 60 miles, and at Eureka, Cal., 50 miles.

The following note relative to high winds at Mount Washington, N. H., is taken from the MONTHLY WEATHER REVIEW, February, 1886:

The 8-hour movement of the wind from 3 to 11 p. m. of the 26th was 925 miles, being at the rate of 115.6 miles per hour, and largely in excess of any previous 8-hour movement ever recorded at this station. The total movement of the wind for twenty-four hours ending 3 p. m. of the 27th was 2673 miles, being 533 miles in excess of any previous 24-hour movement. During the night of the 26-27th the terrific hurricane caused the building to rock and tremble; huge masses of frostwork were dashed against the station building with reports as loud as the discharge of a cannon.

The wind records at Pikes Peak have been published, but the volume is not accessible to the writer.

In connection with this high northwest wind of May 16-19, it only remains to be said that at San Francisco during the same period there were recorded 1311 miles, distributed during each twenty-four hours as follows: 415, 411, and 485. From 6 a. m. of the 18th to 6 a. m. of the 19th 531 miles were recorded.

At Point Lobos (see fig. 2), the extreme northwestern end of the peninsula on which San Francisco is situated and about five miles west of the Mills Building, the following velocities were recorded: May 16-17, 586 miles; 17-18th, 890 miles; 18-19th, 938 miles, or for the entire seventy-two hours, 2414 miles, which is about 33 per cent of the air movement at Point Reyes. Between 9 and 10 p. m., May 18, 53 miles were recorded; maximum 5-minute record, 72 miles, at 7 p. m., May 18. On Mount Tamalpais, Cal., for the three days under consideration the velocities were 1096, 1123, and 1002 miles, respectively, or in all 3121 miles, being 44 per cent of the Point Reyes movement. The maximum velocities were: May 16, 86 miles; May 17, 75 miles; May 18, 69 miles, and May 19, 69 miles.



FIG. 2.—United States Weather Bureau station and storm-warning tower, Point Lobos, Cal.

With reference to the actual velocities experienced by vessels, it is interesting to note that the steamer *George W. Elder*, leaving San Francisco on the morning of Sunday, May 18, found it impossible to pass Point Reyes Light and had to put into Drakes Bay for fourteen hours. In the same place the *Elder* found the big Kosmos liner *Scrapis*, a collier, and a fleet of schooners; none of them had been able to get around the point.

Of even greater interest is the experience of the British ship *Westgate*, which arrived at San Francisco May 27, after being driven 1000 miles out of her course. On May 17, when

within 50 miles of port, the strong northwest wind drove her nearly 1000 miles to the southward. It required ten days to make port. The following is a statement by Captain Neville:



FIG. 3.—Approach to Weather Bureau station at Point Reyes Light. Camera pointing south of east and tilted up at a small angle.



FIG. 4.—Water tank on bluff at Point Reyes carrying the anemometer at the time of the high wind of May 18, 1902. Point Reyes Light is shown to the left of the water tank and below it, on the bluff next beyond.

We left Newcastle, Australia, for San Francisco ninety-two days ago with 2084 tons of coal. It was one of the most uneventful voyages I ever made until we were within 750 miles of San Francisco. We encountered nothing but light winds and calms all the way, but nevertheless we made fair time. When about 750 miles from port the weather began to get dirty. Still I thought we could make our distance and run in through the Gate before the storm broke. I was mistaken. When within striking distance of our destination the storm came down and we had to 'bout

ship and run for the open sea. In all the years I have been to sea, I never saw a gale to equal the one of May 17 and 18. Mountainous seas broke aboard and the ship labored so heavily that at times I thought she would roll the masts out of her. The lower topsail and foresail went out of the boltropes like a kite escaping from its anchor, and for a time the ship ran under bare poles. After two hours hard work we got a goose-winged lower topsail set, and under it the *Westgate* rode out the storm. From that day to this we have had nothing but light winds, calms, and fogs. * * * We sustained no damage during the norther, except having whatever was movable on deck washed overboard.



FIG. 5.—Water tank and anemometer at Point Reyes Light, as seen looking west-southwest. Dimensions: Base of tank, 4 feet above ground; height of tank, 16 feet; diameter of tank at the top, 19 feet, 3 inches; diameter of tank at the bottom, 20 feet, 6 inches; height of anemometer support, 10 feet, 4 inches; height of cups above ground, 30 feet; height of cups above sea level, 490 feet, approximately. The anemometer support is placed near the western edge of the top of the tank.



FIG. 6.—Storm warning tower and new point of exposure for the anemometer. Height of anemometer cups on the tower, 53 feet above the ground and about 593 feet above sea level.

On May 27, in connection with the paper above printed, Professor McAdie submitted a photographic reproduction of the anemometer record for May 16-19, showing 4701 recorded miles in the three days, 17th, 18th, and 19th; he added an enlargement of a portion of the record, showing 102 miles recorded during the hour 8-9 p. m., of May 18, with a maximum velocity at the rate of 110 miles during the five minutes 8:47-8:52 p. m.

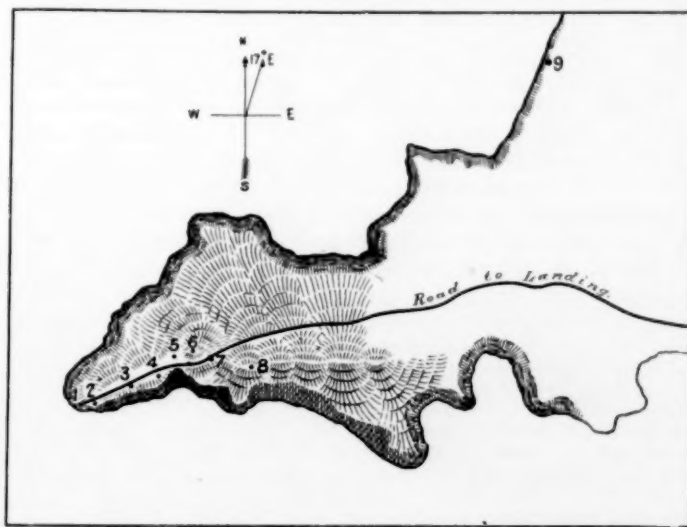


FIG. 7.—Plan of Point Reyes Peninsula, according to a survey made in 1880 by United States Engineer Corps. 1. Fog signal station; elevation 100 feet. 2. Light-house tower; elevation 250 feet. 3. Steps and chute leading to the light-house and signal stations. 4. Tank; elevation 460 feet. Anemometer on the tank; elevation 490 feet. 5. Weather Bureau building; elevation 490 feet. 6. Location of the new storm-warning tower; the ground at the tower is 540 feet; the peak is 550 feet high; the anemometer on the tower is about 593 feet above sea level. 7. Residences of the keepers. 8. Highest point of the ridge; elevation 597 feet. 9. Life-saving station.

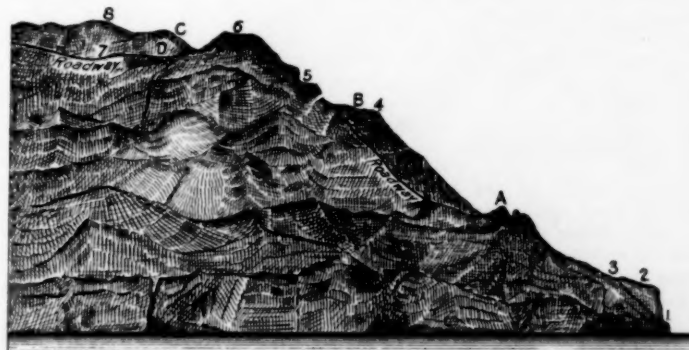


FIG. 8.—Contour of Point Reyes, as seen from the northwest. 1. Fog signal; elevation 100 feet. 2. Light-house tower; elevation 250 feet. 3. Steps and chute leading to the light-house and signal stations. 4. Watertank; elevation 460 feet. 5. Weather Bureau building; elevation 490 feet. 6. Storm-warning tower; elevation of ground 540 feet. 7. Dwelling of light-house keeper. 8. Highest point of the ridge; elevation 597 feet. A. Point from which photograph C, or fig. 3, was taken. B. Point from which photograph A, or fig. 5, was taken. C. Point from which photograph B, or fig. 6, was taken. D. Former exposure of the anemometer.

[The Editor regrets that these photographs as submitted can not be reproduced by the half tone process; on the other hand, any copy made by hand would lose the advantage of being a facsimile reproduction. The records are remarkably clear and uniform, so that there can be no doubt as to the accuracy of the rate of movement.]

Under date of May 27 the Observer in Charge, Mr. W. W. Thomas, writes as follows:

In reply to your inquiry regarding the loss of the anemometer cups, I have the honor to say that I delayed further report upon this matter with the hope that in the meantime I could find the cups and from their condition report definitely as to how they gave way; however, the cups can not be found and the defect that resulted in their loss must therefore remain a theory. The miles of wind were recorded with such rapidity and regularity up to the very moment of the loss of the cups as to show that the screw that holds the cups to the spindle was constantly tight, which dispels the theory that this screw had worked loose, thereby allowing the cups to be lifted off; therefore, my only remaining theory is that under the terrific and long-continued strain one or more of the cross arms gave way and probably bent upward, which gave the wind a sudden, highly increased power on the cups that snapped the screw above referred to and instantly released the cups from the spindle. The anemometer was not injured, aside from the loss of the cups, and in order to expedite the resumption of the record, I left it exposed, simply putting on a new set of cups.

The 20 miles of wind interpolated at the time of the break (9:19-9:36 p. m.) have been added to the dial, so that the dial readings correspond to the record.

Under date of June 5, 1902, and in reply to the preceding, Prof. C. F. Marvin wrote, as follows:

Inasmuch as the spindle of the anemometer was intact and the cups entirely removed, I am inclined to think the only plausible explanation is that the cups, by the action of the storm, were detached from the spindle, either because the screws binding the cups to the spindle were not secured tight enough, or because of action from the storm the screw backed off a little and permitted an upward gust to lift the cups from the spindle. From the photograph inclosed with the report it is obvious that there must be a very pronounced upwardly inclined direction to the wind at the point of exposure of the anemometer, thus facilitating the lifting of the cups from the spindle. I would remark in regard to Mr. Thomas's conclusions, that the cups must have been tight on the spindle because the movement of the wind is registered regularly up to the very moment of the loss of the cups, that this is not necessarily the only one to be drawn. The spindle of the anemometer turns with such extreme freedom in its bearings that the very much greater friction between the cups and the spindle, even when the clamping screw is not tightened, is generally sufficient to keep the cups in continuous rotation, and it seems probable that the cups might have been working loose on the spindle for some time before the moment they were actually carried away.

Under date of June 27, 1902, Professor McAdie says:

It is doubtful if these high winds experienced at Point Reyes Light and at other points along the coast are really forced draughts. We have been in the habit of considering that this was so, but the truth can only be established by a set of comparative readings. If we may rely upon the reports of vessel masters these strong winds prevail at sea level and at some distance from the shore. While the topography is such as to accentuate air movement, the effect can not be justly described as a funnel effect because the velocities attained when the wind veers from the southeast to the northwest are equally high and this should not be the case if topography controlled the velocity. At San Francisco, with our so-called southeasters, the wind has been known to reach a velocity of over 50 miles an hour from the southeast and within a few moments an equal velocity from the northwest.

On the dates under consideration (May 16-19) it will be remembered that there was an unusually high velocity reported at nearly all points along the coast, and also at a number of interior points.

NOTE ON THE ANEMOMETER EXPOSURE AT POINT REYES LIGHT, CAL.

By C. F. MARVIN, Professor of Meteorology, dated February, 1903.

Prior to the erection of the Weather Bureau building to accommodate the station at Point Reyes Light the anemometer was exposed on a water tank located on the side of the bluff. A view of this location is shown in fig. 5. The excessive wind movement recorded at this locality, as set forth in Professor McAdie's paper, preceding, led us to question whether this was not due, at least partially, to a faulty exposure and to a strong draft of wind around the point of the bluff. In order to secure information on this point, extensive comparisons of wind movement have been conducted by installing a duplicate anemometer exposed on an attachment to the storm-warning tower erected very nearly on the summit of the bluff, as indicated in figs. 3 and 6. The anemometer cups were about 53 feet above the ground at the base of the tower—that is, about 593 feet above sea level. The anemome-

ter on the tank had an elevation of about 490 feet above sea level. The relative location of these anemometers is more clearly indicated in figs. 7 and 8, which give the approximate plan and contour of the bluff.

The two anemometers were in all respects alike and recorded automatically side by side on a special two-magnet register. Comparative readings extended from noon, September 19, 1902, to noon, February 1, 1903. The following table gives the total monthly movements for the two anemometers:

Months.	Total monthly movement.		Maximum hourly movement.		Ratio.	Average hourly movement.		Relative monthly movement. Tank ÷ tower.
	Tank.	Tower.	Tank.	Tower.		Tank.	Tower.	
1902.								
October.....	14,466	13,519	62	59	1.05	19.4	18.2	1.07
November.....	15,393	14,792	77	74	1.05	21.4	20.5	1.05
December.....	12,385	12,225	58	53	1.09	16.6	16.4	1.01
1903.								
January.....	12,112	11,764	74	67	1.10	16.3	15.3	1.03

The hourly readings were tabulated for the entire period, but a careful examination of these fails to disclose any important results that are not also presented by the total monthly movements. It is apparent, from the tables, that the anemometer on the tank recorded from 1 to 7 per cent greater monthly movements than the anemometer on the tower.

Extended comparisons of anemometers at the Weather Bureau have demonstrated that differences in the indications of instruments that are of similar design and construction are caused principally by inaccuracies in the lengths of the arms of the anemometer cups, that is, by differences in the mean distance of the centers of the cups from the center of the axis of revolution.

In the case of the anemometer cups used in the present comparisons at Point Reyes Light, careful measurements show that the arms of the tank anemometer are 0.015 of an inch shorter than those of the tower anemometer. This is a difference of only 0.22 per cent, that is, we should expect the tank anemometer to show one-fifth of 1 per cent more wind movement than the tower anemometer.

The actual difference found from comparisons of the records at these two stations amounts to from 5 to 10 per cent for the maximum winds and from 4 to 6 per cent for the monthly movements, and must be attributed to some peculiarity of the exposure on the tank and to the variation in the direction of the wind.

From the foregoing it may be assumed that the extraordinary wind velocities recorded during the storms reported by Professor McAdie were fairly well indicated by means of the anemometer on the tank. In this connection, however, it is necessary to remark that accurate studies of the Weather Bureau type of Robinson's anemometer have never been extended to velocities above 50 miles per hour, at which speed the velocity indicated by the instrument is 9.2 miles or 18 per cent too high, so it is very probable that the wind movement producing an indicated velocity of from 100 to 120 miles per hour on the Weather Bureau anemometer was actually much less than 100 miles per hour. It is very greatly to be desired that researches should be undertaken to evaluate the indications of our anemometers at the very highest velocities ever indicated.

COMPOSITE AND OTHER ARRANGEMENTS OF WEATHER TYPES.

By H. W. RICHARDSON, Local Forecast Official, Duluth, Minn., dated March 17, 1903.

During recent years considerable attention has been devoted to the classification and indexing of weather maps and types as an aid to the forecasting, the most prominent contributors

to this special literature being Profs. Thos. Russell, E. B. Garriott, and M. V. Brown, Mr. F. H. Brandenburg, and Rev. F. L. Odenbach, S. J., all of whom have placed before us very valuable information and suggestions. One might also include in the above list Prof. F. H. Bigelow's Storms and Storm Tracks.

No one will dispute Professor Garriott's statement that "types of formations and movements of the same general character, extending over periods of several days, are much more important than types of individual conditions," nor that of Professor Brown to the effect that the idea of individual types must not be pushed too far, in the expectation that conditions apparently alike will always produce like results. On the other hand there is no question but that the study of individual types is very profitable, for, in many cases, certain characteristic conditions are a safe guide to the forecaster.

The writer has given the subject considerable attention, and, perhaps, some of the methods evolved and followed may prove of interest to others. For over four years past it has been my daily habit to enter upon each "pencil" map the local forecasts and the actual conditions that prevailed at Duluth in the succeeding twenty-four and thirty-six hours, that is, during "to-night and to-morrow" as regards weather, temperature, and wind. This systematic record has proved valuable as facilitating the study of types in their relation to local forecasting, especially as one does not need to refer to any other source to obtain precise information as to results when examining maps. This method permits easy separation and arrangement of types in a variety of ways. Up to the present time three methods of classification have been attempted, as follows:

- A. Composite types.
- B. Associated types.
- C. Scrap-book arrangement. Chronological order.

(A.) The composite is an extremely interesting method. This is a chart compiled from a large number of maps, each of which produced certain similar effects, the final result being an average of the data for each station from which reports were received on the several dates. By this means one obtains a purely ideal map for a large district or locality as regards any stated phase of weather, temperature, or wind, separately or combined. The chief value to the forecaster is the knowledge gained as to average conditions producing a type. After the composite is prepared it should be compared with each of the relative or contributing maps in order to note variations in position, movement and strength of the highs and lows, pressure and temperature changes, precipitation areas, etc. To secure the best results, composites or other methods of studying types should cover not less than a year on account of the changes attending the procession of the seasons, but periods of five or ten years would be more satisfactory because of other variations that occur from year to year.

Quite a complete set of composites (8 a. m.) have been prepared for the month of March, those for other months are in course of preparation. These refer to the following conditions: Brisk and high northeast winds; light and fresh northeast winds; fresh northerly winds; fresh westerly winds; brisk and high northwest winds; fair weather; snow or rain; stationary temperature; warmer to-night, colder to-morrow; colder to-night, stationary temperature to-morrow; colder (also cold waves); warmer.

Two of the above types are illustrated by the accompanying figs. 1, 2, 3, and 4, viz: Brisk and high northeast winds to-night and to-morrow, by figs. 1 and 2; and fair weather to-night and to-morrow, by figs. 3 and 4. The former is about the most important of all in this locality (excepting the high northwest wind type that is usually confined to the colder months in its greater severity), for it is experienced in varied

moods during about eight months in the year. In its lighter phases it is quite frequently accompanied by fine and delightfully cool weather, but when fully developed there is much wind, fog, rain or snow, heavy sea and disagreeably cool temperature. The low shown near Omaha, see fig. 2, moved oftenest from the Alberta or Montana region in twenty-four hours. By 8 a. m. of the succeeding date it had generally moved between three hundred and four hundred miles farther eastward, and thence its path was northeastwardly across the Lake region. Of course there were numerous instances where this low was farther west than Omaha as regards like effects, and where it moved to Nebraska from either the west or southwest. During the twenty-four hours following, the Pacific, Atlantic, and Manitoba highs usually remained about stationary, the latter taking an eastward course after the low entered the Lake region. The high northeast type is 80 per cent in favor of rain to-night and about 90 per cent for rain to-morrow, the amounts of precipitation averaging heaviest during the day hours. The local temperature changes were generally slight, inclining toward colder by 8 p. m. the next day, and the average maximum velocities ranged from forty miles for to-night to about forty-five for to-morrow.

In the fair weather type, see figs. 3 and 4, in the great majority of instances the barometer was high in districts north of the Dakotas and over the Rocky Mountains, and low in either the Lake region, New England, the extreme Southwest or Alberta. The temperature changes were usually unimportant and the winds variable.

(B.) The associated types cover the the same field as the composite only not as averages. The printed maps (Form E) are utilized. Three separate divisions are followed, viz:

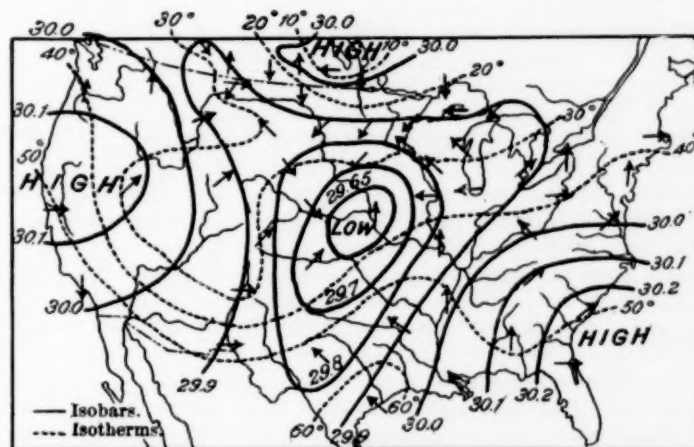


FIG. 2.—Average barometer and temperature changes in the type causing brisk to high northeast winds at Duluth during March.

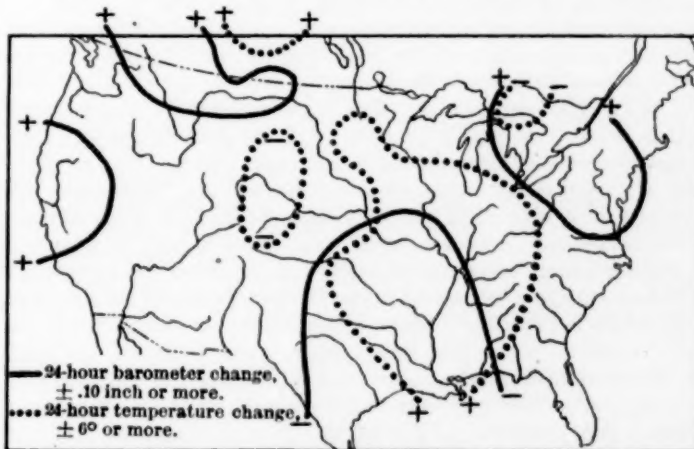


FIG. 1.—Composite or average type causing brisk to high northeast winds at Duluth during March.

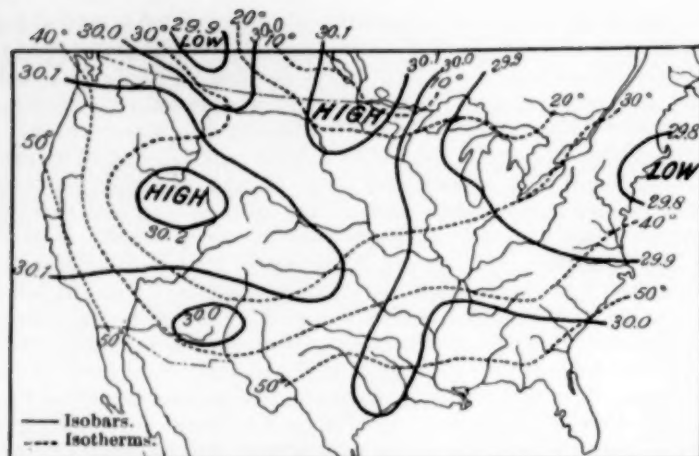


FIG. 4.—Average barometer and temperature changes and precipitation areas in the type causing fair weather "to-night and to-morrow" at Duluth during March.

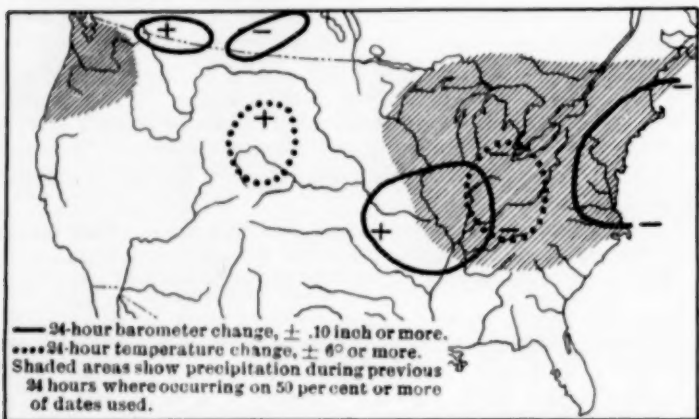


FIG. 3.—Composite or average type causing fair weather "to-night and to-morrow" at Duluth during March.

Weather, temperature, and wind, and three maps are used daily (except Sundays and holidays), one for each condition. Each map includes precipitation, pressure, and temperature change areas in black, red, and blue pencil, respectively, and the paths of the pressure areas are also indicated. On each map are also brief notations covering weather, temperature, and wind for to-night and to-morrow; thus each individual map contains a complete history of the conditions that followed during the succeeding twenty-four and thirty-six hours and their relation to a particular type. As the types accumulate they are pasted together and each group is plainly marked. Thus we have all the fair weather maps together, and the same for rain or snow, cold waves, colder, warmer, stationary temperature, high or light winds, etc. A complete set of these types has been arranged for each month of 1902, the labor requiring but a little time each day.

(C.) In the scrapbook plan a conveniently large blank book is used. A year's supply of 2 by 4-inch maps of the United States and Canada were milliographed. Two of these maps are used daily (including Sundays and holidays). The maps are of a size that permits four being used on a page. On the left-hand page are pasted (in chronological order) the maps containing isobars and isotherms, and on the opposite or right-hand page are pasted maps showing precipitation, areas of pressure and temperature changes for dates corresponding to maps on the left. Progressive movements of the highs and lows are indicated. The local and State forecasts are entered opposite the appropriate map, and likewise data as to weather, temperature, and wind conditions that resulted "to-night and to-morrow." The arrangement is such that when the book is open eight maps for four dates are at once in view.

Besides preparing the maps in the manner described, a system of indexing is also followed. In the front part of the book are pages devoted to the various types of weather, temperature, and wind, each map (or date) being given a number. This shows the frequency and continuity of each type. It not only affords a study of individual types, but also furnishes a method of studying those whose movements extend over periods of several days.

In all the foregoing arrangements of types the 24-hour pressure changes were used, instead of those for twelve hours. This was rendered necessary by reason of the fact that the 12-hour changes were available only for the Northwest; therefore they were of little value.

Among the features developed by these studies is the apparent tendency of the highs and lows to move from near the center of a pressure change area to the edge of the same area or to a point between the plus and minus areas in twenty-four hours. When the highs and lows lie between plus and minus areas they frequently move to near the center of the pressure change areas in twenty-four hours. As these areas are generally of irregular size and conformation, so, also, the movements of the highs and lows become little or great accordingly. While the rules do not always obtain, yet the occurrence is so frequent as to be of some value in forecasting when considered in connection with the other laws governing atmospheric motion.

METEOROLOGY IN THE NATIONAL AGRICULTURAL INSTITUTE OF FRANCE.

By Miss R. A. EDWARDS, Library, Weather Bureau.

The National Agricultural Institute of France has recently issued the first volume of the second series of its *Annales*, which appears on the occasion of the twenty-fifth anniversary of the Institute. From the introduction we learn that the special purpose of this volume is to present to the agricultural and scientific world the history, the work, and the organization of this institution. Condensed accounts are given of the various courses of instruction offered, among which we notice meteorology. Teachers in general, and especially those in the colleges and technical schools of this country, may be interested to know to what extent meteorology receives attention in other countries. This course consists of twenty-five lectures delivered by Prof. Alfred Angot, the well-known meteorologist of the Bureau Central, who also holds the chair of physics and meteorology in the National Agricultural Institute of France. The following is a translation of the syllabus of his lectures.

Object and subdivisions of meteorology. Relations of meteorology to the other sciences, e. g., geography, agriculture, hygiene, history.

General methods of calculation. Averages; discussion of their value; application of graphic methods to the representation of phenomena.

Actinometry. Annual and diurnal variation of the quantity of heat received in different latitudes; influence of the atmosphere and the atmospheric absorption of solar rays; measure of the quantity of heat and of light which reach the soil; actinometers.

Temperature of the soil. Diurnal and annual variations of the temperature of the soil at different depths; effect of sod covering; of snow covering; variation of average temperature with depth.

Temperature of waters. Springs, rivers, lakes; annual variation; temperature of the sea at surface and at depths; of ocean currents; limits of icebergs.

Temperature of air. Methods of observation; thermometers, maximum, self-registering, sling; installation of thermometers.

Diurnal variations of the temperature of the air; influence of seasons; of latitude; of topographical conditions. Annual variation of temperature; climates, equable, temperate, extreme; variation of temperature of atmosphere with altitude.

General distribution of temperature at the surface of the globe by the annual averages and by the different seasons; extreme temperatures observed in different regions.

Influence of temperatures on phenomena of vegetation; effect of frosts; of altitude; limits of different vegetations; influence of temperature on animal life.

Atmospheric pressure. Instruments for measurement; barometers; aneroid, mercurial self-registering; thermometric-hypsometry; diurnal and annual variation of atmospheric pressure.

Variation of pressure with altitude. Laplace's formula; applications; reduction of pressure to sea level; calculation of altitudes by means of barometric observations.

Wind. Measurement of direction and of velocity of wind; weather vanes; velocity anemometers; pressure anemometers.

Diurnal variation of velocity and of direction of wind. Variation of wind with altitude; general relation between the wind and pressure; gradients; theory of atmospheric movements; relation of wind to temperature; influence of rotation of earth; deviation of wind on gradient.

General circulation of the atmosphere. Regular winds; trades, antitrades; distribution of wind and pressure at the surface of the globe; seasonal winds; monsoons; diurnal winds; land and sea breezes, mountain and valley breezes.

Atmospheric vapor. Evaporation; measure of evaporation; diurnal and annual variations of evaporation; general laws of evaporation.

Atmospheric humidity. Elastic force of water vapor; relative humidity; instruments of measurement; hygrometers; chemical; condensation; self-registering; psychrometer.

Diurnal and annual variations of humidity. Variation of humidity with height; distribution of humidity at surface of earth; condensation of water vapor, various modes of condensation in the ascending currents of air; dryness in the descending currents; production of the foehn.

Properties and constitution of clouds and fogs. Cloudiness; measure of cloudiness; heliograph; annual and diurnal variations of cloudiness; general distribution of cloudiness at the surface of the earth; study of movements of clouds; classification of clouds; average altitude of different forms of clouds.

Optical phenomena of the atmosphere. Rainbows; halos; coronas.

Dew and Frost. Formation of dew; measurement of dew; practical importance of these phenomena; frost; hoar frost; glazed frost.

Rain, snow, hail. Measurement of rain; rain gages, their installation.

Theory of the formation of rain. Rains of various origins; rains due to convection; cyclonic rains; rains due to orography; influence of topographical conditions, of forests.

General distribution of rains at the surface of the globe. Rainy regions; desert regions; detailed study of rain in the different regions; rainfall system; distribution of rain throughout the seasons; intensity of heavy showers.

Snow. Constitution and density of snow; effect of snow; limits of perpetual snow.

Natural utilization of meteoric waters. Percolation; surface flow; water consumed by evaporation and by vegetation; supply of underground waters, of springs, and of rivers; drainage system of water; risings and floods, their prevision.

The law of storms. Depressions of temperate latitudes and cyclones of tropical regions, their constitution; distribution of wind about centers of low pressure.

Influence of barometric depression on the weather. Local winds produced by the passage of depressions; mistral, sirocco, foehn, bora, etc.

Laws of movements and of frequency of barometric depressions and of cyclones; their velocity, their average paths. Various causes of the circulatory movement; causes which tend to modify their velocity, their paths, or their intensity.

Anticyclones, their origin. Influence of anticyclones on the weather.

Thunderstorms. Atmospheric electricity, lightning, flash of lightning, thunder; frequency of hourly, seasonal, and geographical distribution of thunderstorms; origin of thunderstorms, thunderstorms of heat, and cyclonic thunderstorms; hail, formation of hail; means proposed for defense against hail.

Whirlwinds and waterspouts, their effects, their origin, and their relations to thunderstorms; heat storms.

Forecasting. Short range system of forecasting; organization of forecast service; general principles of forecasting.

Forecasting by isolated observers. Utilization of observations and of local signs; prevision of frost in spring time.

Discussion of attempts to forecast at long range.

Cosmical influences. Periodicity of sunspots, discussion of relations they present to meteorological phenomena. Discussion of influences attributed to the moon; reddish sunset; other influences attributed to cosmical causes.

Problem of variability of climates. Can man influence climate? Effect of deforestation, of reforestation.

Attempts to produce rain.

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the

meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a —.

Quarterly Journal of the Royal Meteorological Society. London. Vol. 29.

Bayard, F. C. English Climatology, 1881-1900. Pp. 1-21.

— The Bora in the Adriatic. P. 21.

Bellamy, C. V. The Rainfall of Dominica. Pp. 23-28.

Bellamy, C. V. Notes on the Climate of Cyprus. Pp. 29-44.

Clayton, H. Helm. The Eclipse Cyclone of 1900. Pp. 47-52.

— St. Elmo's Fire. [Note on letters from J. Fellows and Charles

Dibdin.] Pp. 55-56.

— Rainfall of the Hawaiian Islands. [Note on pamphlet by C. J. Lyons.] Pp. 56-57.

Terrestrial Magnetism. Baltimore. Vol. 7.

Bauer, L. A. Results of International Magnetic Observations made during the Total Solar Eclipse of May 18, 1901, including results obtained during previous Total Solar Eclipses. Pp. 155-192.

Pegram, Geo. B. Elster's and Geitel's researches on the Radio-Activity and the Conductivity of the Air. Pp. 202-204.

Symons's Meteorological Magazine. London. Vol. 38.

Stupart, R. F. The Canadian Climate. Pp. 1-4.

— Temperature of Air and Rivers. [Note on paper by W. Andson.] Pp. 4-6.

Proceedings of the Royal Society. London. Vol. 71.

Chree, C. Preliminary Note on the Relationships between Sunspots and Terrestrial Magnetism. Pp. 221-224.

Taylor, J. E. Characteristics of Electric Earth-current Disturbances, and their Origin. Pp. 225-227.

Evershed, J. Solar Eclipse of 1900, May 28. General Discussion of Spectroscopic Results. Pp. 228-229.

Science. London. N. S. Vol. 17.

Ward, R. DeC. Scientific Investigations by Weather Bureau men. Pp. 353-354.

Ward, R. DeC. Cycles of Precipitation in the United States. [Note on article by L. H. Murdoch.] P. 354.

Astrophysical Journal. Chicago. Vol. 17.

Langley, S. P. The "Solar Constant" and related problems. Pp. 89-99.

Bigelow, Frank H. Reply to E. von Oppolzer's remarks on Bigelow's "Eclipse Meteorology." Pp. 161-163.

Journal of Geography. Chicago. Vol. 2.

— How the Weather Fixes Train Loads. Pp. 45-46.

Journal of the Franklin Institute. Philadelphia. Vol. 165.

Auria, Luigi d'. Relation between the Mean Speed of Stellar Motion and the Velocity of Wave Propagation in a Universal Gaseous Medium Bearing upon the Nature of the Ether. Pp. 207-211.

Engineering News. New York. Vol. 48.

Clarke, Ernest Wilder. Storm flows from city areas, and their calculation. Pp. 386-388.

Nature. London. Vol. 67.

Lockyer, William J. S. Solar prominences and terrestrial magnetism. Pp. 377-379.

Marriott, Wm. Fall of Coloured Dust on February 22-23. Pp. 391.

B., G. H. The Fata Morgana of the Straits of Messina. Pp. 393-394.

Lockyer, William J. S. Indian Rainfall. Pp. 394-395.

Chree, Charles. Magnetic Work in New Zealand. Pp. 418-419.

Geographical Journal. London. Vol. 21.

— Circulation of the Atmosphere in the Tropical and Equatorial Regions. [Note on statement by Professor Hildebrandsson.] Pp. 298-301.

London, Edinburgh, and Dublin Philosophical Magazine. London. 6th Series. Vol. 5.

Wilderman, Meyer. Theory of the Connexion between the Energy of Electrical Waves or of Light introduced into a System and Chemical Energy, Heat Energy, Mechanical Energy, etc., of the same. Pp. 208-226.

Makower, Walter. On a Determination of the Ratio of the Specific Heats at Constant Pressure and at Constant Volume for Air and Steam. Pp. 226-238.

Schuster, Arthur. The influence of Radiation on the Transmission of Heat. Pp. 243-257.

Thomson, J. J. On the Charge of Electricity carried by a Gaseous Ion. Pp. 346-355.

Journal de Physique. Paris. 4me série. Tome 2.

Baillaud, J. L'influence des atmosphères d'azote et d'hydrogène sur les spectres d'arcs du fer, du zinc, du magnésium, et de l'étain, comparée avec celle d'une atmosphère d'ammoniaque. [Note on article by Royal A. Porer.] Pp. 128-129.

Gradenwitz, A. Comparaison des thermomètres à platine et à hydrogène. [Note on article by B. Meilink.] Pp. 137-138.

- Annales de Chimie et de Physique. Paris. 7me série. Tome 28.*
- Coppet, L. C. de.** Étude expérimentale de la propagation de la chaleur par convection dans un cylindre d'eau à axe verticale chauffé ou refroidi par sa surface latérale. Application à la détermination de la température du maximum de densité de l'eau et des solutions aqueuses. Pp. 145-213.
- Langevin, P.** L'ionisation des gaz. Pp. 289-384.
- Annuaire de la Société Météorologique de France. Paris. 51me année.*
- David, P.** Comparaison des températures prises sous abri en plein air et dans un abri annexé à un édifice, au sommet du Puy-de-Dôme. Pp. 1-3.
- Maillet, Ed.** Résumé des observations météorologiques et hydro-métriques de 1891 à 1900. P. 3-11.
- L'Aérophile. Paris. 11me année.*
- De Rue.** Expériences d'aviation. Pp. 36-40.
- Comptes Rendus de l'Académie des Sciences. Paris. Tome 136.*
- Mascart, E.** La tempête du 2 mars 1903. Pp. 529-530.
- Ciel et Terre. Bruxelles. 23me année.*
- La station franco-scandinave pour l'étude des couches élevées de l'atmosphère. Pp. 587-591.
- L., V. D.** Une pluie extraordinaire. [Note on article by G. Hellmann.] Pp. 608-610.
- Lagrange, E.** Le temps et les télégraphiques. [Note.] Pp. 610-611.
- Ciel et Terre. Bruxelles. 24me année.*
- Chauveau, A. B.** Historique des théories relatives à l'origine de l'électricité atmosphérique. Pp. 1-15.
- Pluie de boue. P. 20.
- Variations périodiques et marche des glaciers. Pp. 22-24.
- Das Wetter. Berlin. 20 Jahrgang.*
- Frenbe, —.** Ein landwirtschaftlicher Wetterdienst. Pp. 25-31.
- Assmann, Richard.** Ueber die Ausführbarkeit von Drachen-aufstiegen auf Binnenseen und deren Vorteile. Pp. 31-41.
- Schwenck, O.** Interessante Raucherscheinung. Pp. 44-45.
- Assmann, R[ichard].** Aus dem Aeronautischen Observatorium. Pp. 46-48.
- Petermann's Mittheilungen. Gotha. Band 48.*
- Isachsen, Gunnar.** Kurze Uebersicht über die Arbeiten der zweiten norwegischen Polarfahrt. P. 269.
- Petermann's Mittheilungen. Gotha. Band 49.*
- Roger, Joseph.** Regenkarte von Europa. Pp. 11-13.
- Annalen der Physik. Leipzig. 4te Folge. Band 10.*
- Walter, B.** Ueber die Entstehungsweise des Blitzes. Pp. 393-407.
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IV. THE MECHANISM OF COUNTERCURRENTS OF DIFFERENT TEMPERATURES IN CYCLONES AND ANTICYCLONES.¹

By Prof. FRANK H. BIGELOW, dated March 27, 1903.

THE WEATHER BUREAU CLOUD OBSERVATIONS.

The report on the international cloud observations of May 1, 1896, to July 1, 1897, Report of the Chief of the Weather Bureau, 1898-99, Vol. II, contained an outline description of a theory of the structure of cyclones and anticyclones, which was thought to be indicated as the probable interpretation of the motions of the air in cyclones and anticyclones. It was evident that a more complete insight into the mechanism of this type of motion in a fluid under atmospheric conditions would be afforded by the construction of systems of isobars on at least three planes having different elevations. For this purpose the sea level, the 3500-foot level, and the 10,000-foot level were selected, and suitable reduction tables have been made as described in the report on the barometry of the United States, Canada, and the West Indies, Report of the Chief of the Weather Bureau, 1900-1901, Vol. II. Since December 1, 1902, we have received daily reduced pressures on these planes from the regular stations of the United States and Canada, and the corresponding charts have been drawn with care by Mr. George Hunt of the Forecast Division. A definitive treatment of the problem evidently requires charts of the isotherms on the same planes, but it will not be necessary to wait for the completion of our discussion of the temperatures, because we have already obtained the approximate gradients needed in a preliminary study of this question. It is proposed to summarize the present status of the research, previous to working out an analytic treatment of the mechanism of tornadoes, cyclones, hurricanes, and the general circulation, from the data now in possession of the Weather Bureau.

THE GENERAL CIRCULATION.

The circulation of the atmosphere has been analyzed by meteorologists into (1) the general cold center cyclone, which covers a hemisphere of the earth from the pole to the equator, and (2) the local warm center cyclones and the anticyclones,

¹No. I was published in the Monthly Weather Review for December, 1902, and Nos. II and III in that for January, 1903.

which drift eastward in the temperate latitudes. Ferrel worked out his well-known canal theory for the general cyclone, with northward motions in the upper and southward motions in the lower strata of the atmosphere. This theory was adopted by Oberbeck and carried out with difference of details, and it has been the prevailing view till the discussion of the Weather Bureau observations of 1896-97 in the United States proved that it is incorrect and must be greatly modified. No northward movement of importance exists in the upper strata, and there is no calm belt separating the eastward drift from a westward current in the polar zone. In the Tropics the motions are substantially those deduced by Ferrel, and they result naturally from the equations of motion on a rotating earth heated in the equatorial belt. Professor Hildebrandsson's report on the International Cloud Observations confirms these facts for Europe and Asia generally, and therefore we conclude that they are fundamental, and that the canal theory must be finally abandoned. The Weather Bureau report showed that the incoming solar radiation of short waves heats the atmosphere only a little, but that it does heat up the earth's surface. This latter radiates much longer heat waves at terrestrial temperatures, and thereby the lower strata of the atmosphere are heated up by convection currents to a distance of two or three miles. This heat energy is very vigorous in the Tropics, and produces currents of warm air which leak outward and flow toward the poles only in the lower strata instead of in the high levels, determining by their motion the local distributions of pressure near the surface of the earth. By an analogous process cold currents flow from the higher latitudes toward the equator at low or moderate elevations. These counter currents meet in the middle latitudes, as over the United States, and we have now to study the action of the resulting mechanism.

THE LOCAL CIRCULATION IN CYCLONES AND ANTICYCLONES.

In order to account for the phenomena observed in cyclones and anticyclones, there have been two distinct lines of discussion, (1) the thermodynamic theory and (2) the hydrodynamic theory. The former required a warm central current of rising air to form a vortex. The Espy hypothesis, that the heat necessary to drive the vortex is derived from the latent heat of condensation evolved in changing aqueous vapor into water of precipitation, has been strenuously maintained by many students. There are, however, numerous serious objections which can not be set aside, and these have caused during the past few years a general abandonment of the theory as a true account of the primary cause of cyclones. Ferrel worked out his theory by means of a special type of vortex with closed boundaries, but this does not, unfortunately, in the least satisfy the observations, and it has been rejected as the result of such discrepancy. The equations of motion admit of solution by a different vortex, which more nearly conforms to the requirements of the problem, but no driving force sufficient to sustain a cyclone was discovered before the one suggested by the Weather Bureau research, so that up to recent times the local vortices remained to be fully accounted for on a sound physical basis. The second theory of the local circulation considers it as simply a question in hydrodynamics, where the local thermal force is subordinate to the driving action of the great whirl which gyrates about the pole as a center. In this view the eastward drift simply curls up at places and forms eddies in the great current, and they are borne along by it. This seems to be the general idea adopted by Professor Hildebrandsson in his recent report. There is undoubtedly a certain amount of dynamic action which enters into the construction of cyclones, but there must also be a powerful mechanical force derived from the effort to restore the thermal equilibrium between currents of different temperatures. We shall, therefore, endeavor to trace out these processes more

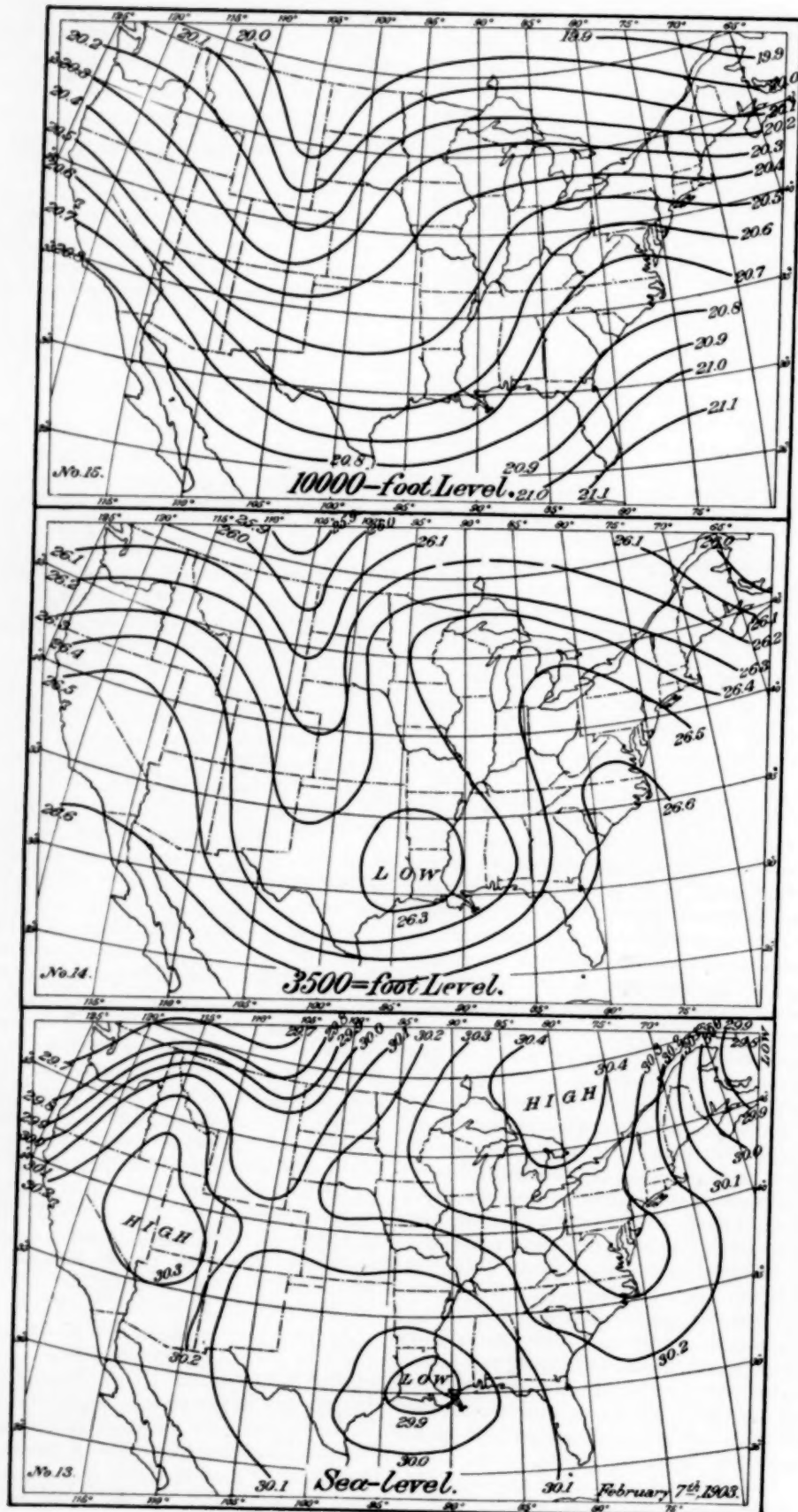
fully than it was possible to do a few years ago and explain a very probable theory of the interaction of the forces that generate and sustain these local storms.

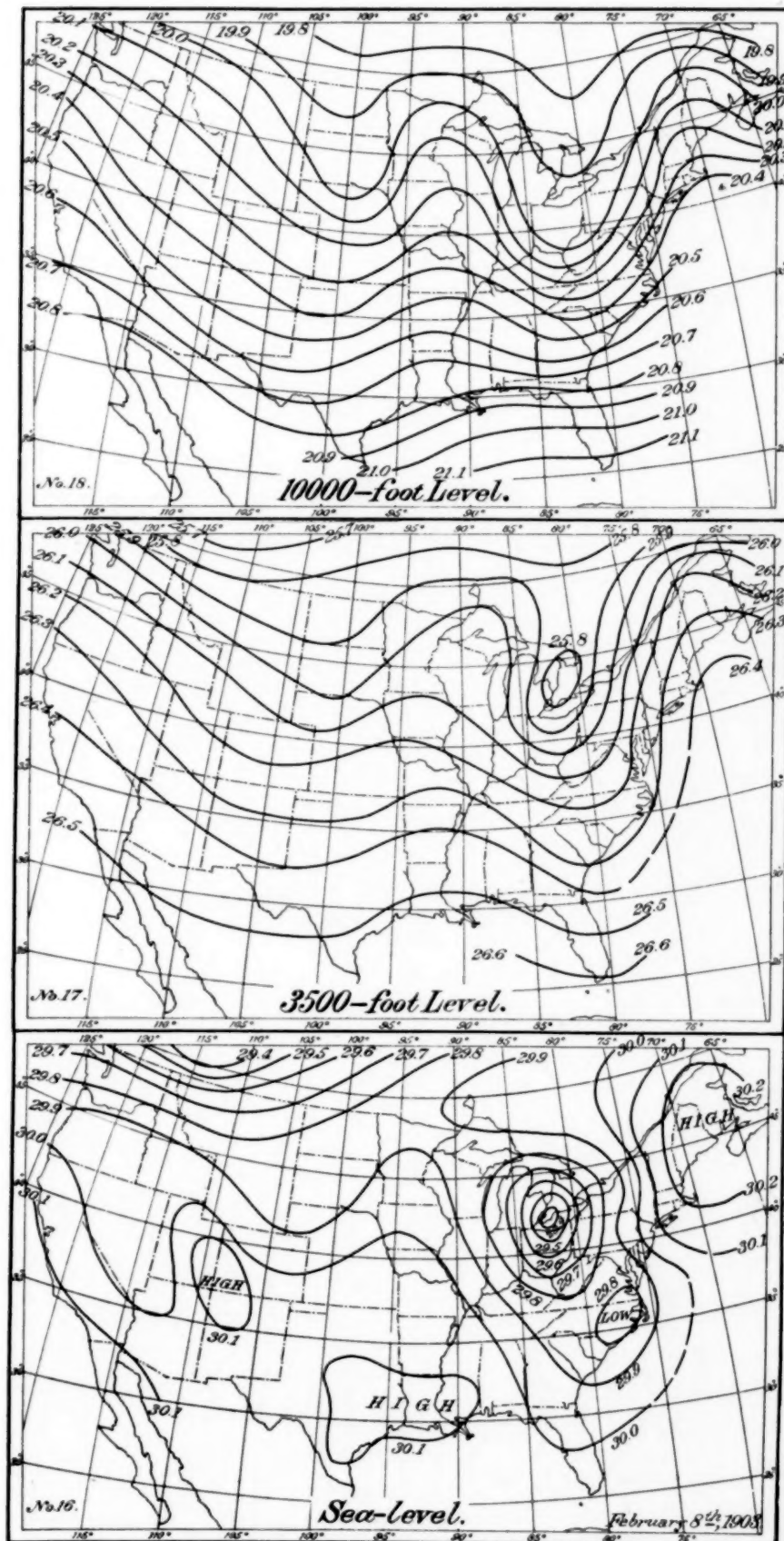
THE ISOBARS AND STREAM LINES ON THE SEA-LEVEL PLANE, THE 3500-FOOT PLANE, AND THE 10,000-FOOT PLANE.

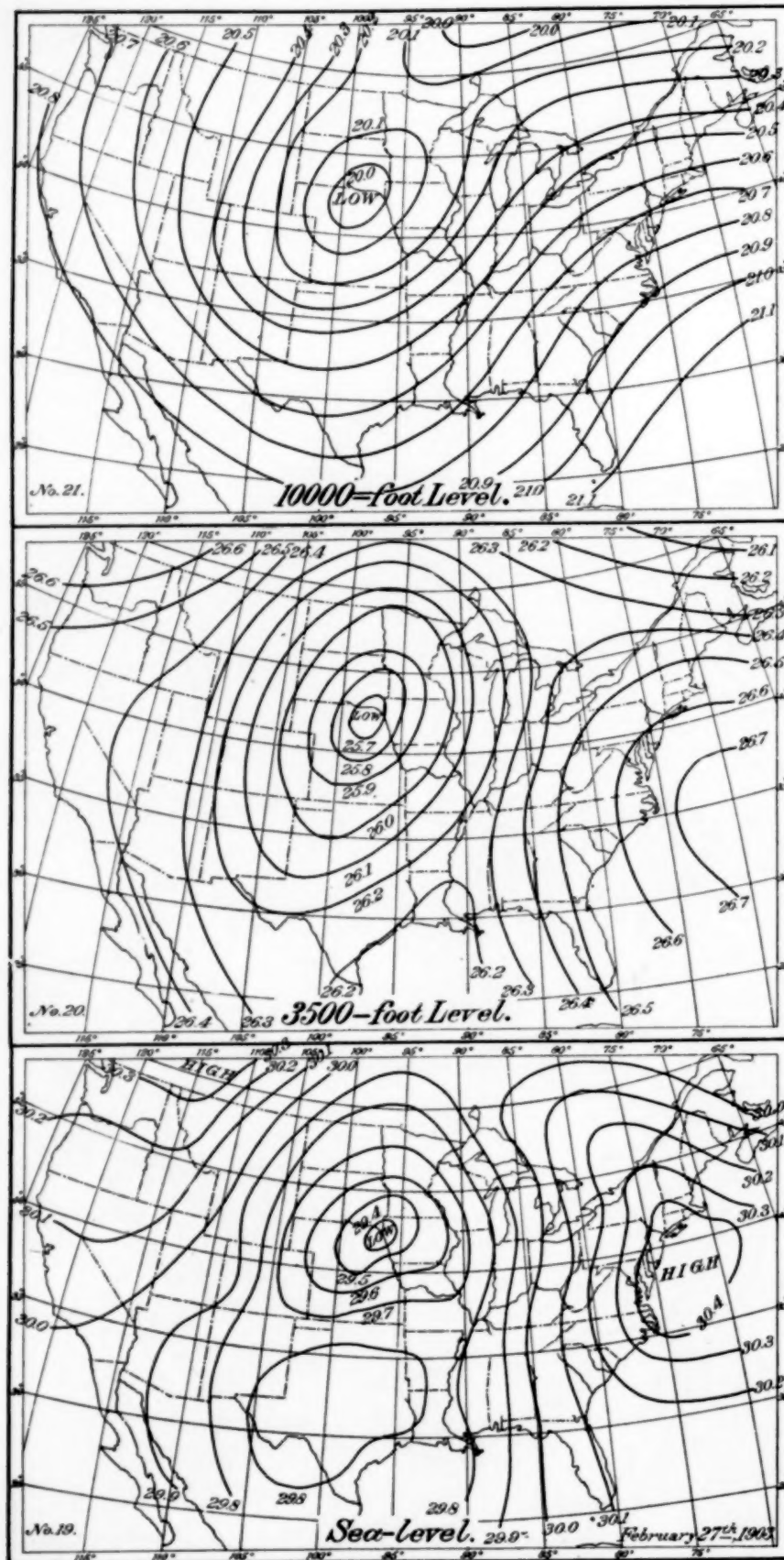
It is first necessary to recall briefly the results derived by the Weather Bureau in its research into this problem. A consideration of the available meteorological observations above the surface of the ground convinced me that it would be necessary to depend upon computations rather than upon direct observations, in order to obtain the daily synoptic pressures and temperatures upon any given reference plane. Observations by balloons, kites, theodolites, or nephoscopes are indispensable in order to secure the necessary data for making the reductions and for checking the results, but it is not possible to make observations on any elevated plane in sufficient numbers to construct a daily map of the weather conditions without adding many laborious corrections. It was, therefore, apparent that suitable methods of computation must be devised for this special purpose in order to reduce the problem to practise. The Weather Bureau now possesses complete barometry tables for the isobars on three planes, and is working out the data for the corresponding isotherms. We have, however, approximate temperature gradients which can be used for the present, in all the preliminary discussions. The thermodynamic formulae for the α , β , γ , δ stages have been adapted to tables for the computation of B , t , e at different elevations. It was indispensable to substitute these tables for the Hertz diagram, because that is liable to an error as large as 7 millimeters, owing to the neglect of the vapor tension in evaluating the numerical data. Since we require vertical gradients of pressure to within 0.01 millimeter, it is practically impossible to secure that degree of accuracy if the vapor tension is rejected.

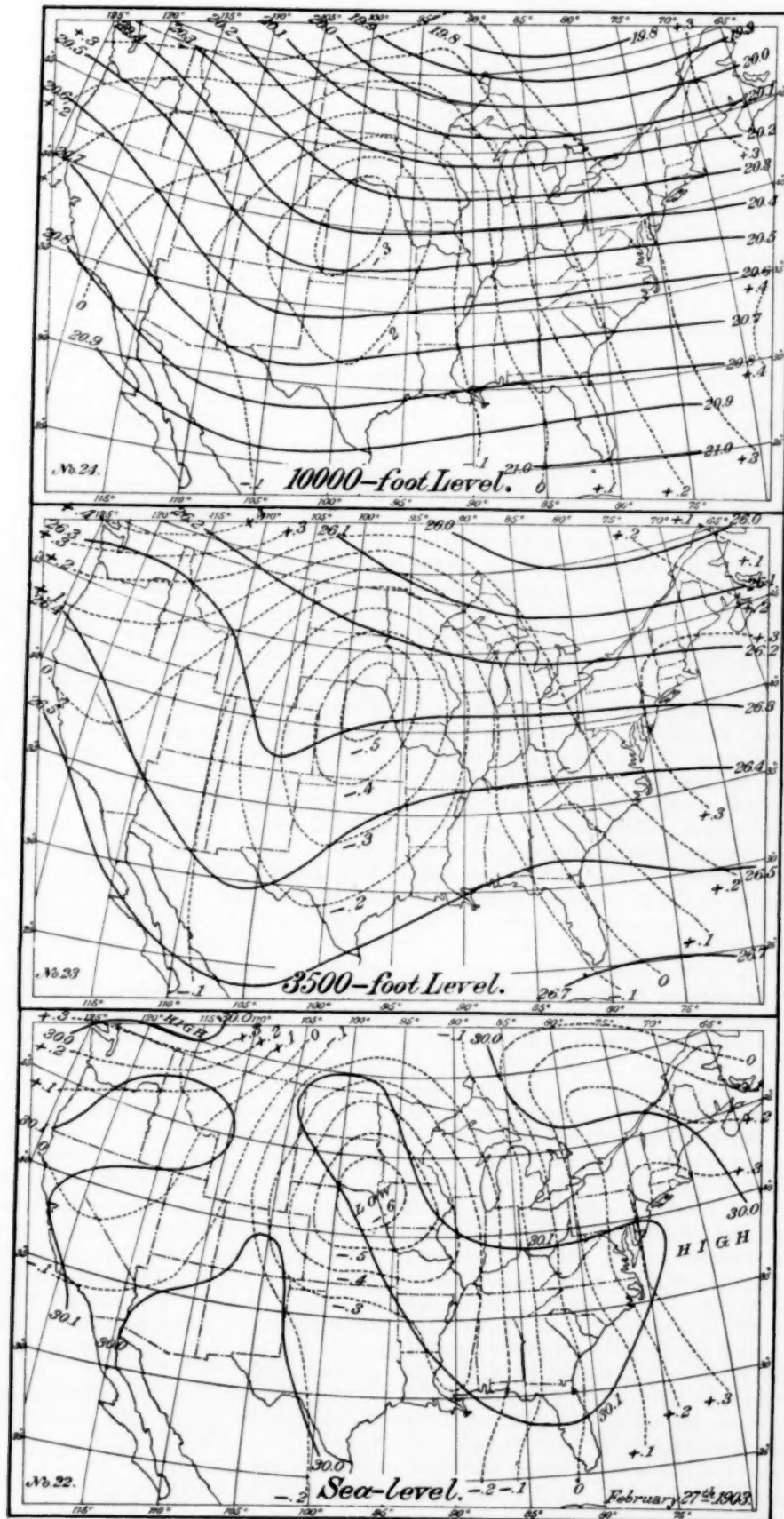
In the MONTHLY WEATHER REVIEW for January, 1903, charts of the isobars, figs. 1 to 6 for January 2, and figs. 7 to 12 for January 7, are given on the three planes; the two components into which they were resolved are also charted, namely, the normal isobars for the month, as given on Charts 28, 30, and 31 of the Barometry Report, and the local disturbing isobars, which are approximately circular in form at the center, the other lines having special curvatures which will be explained. In the present paper there are similar charts, figs. 13 to 15 for February 7, 16 to 18 for February 8, and 19 to 24 for February 27. In order to resolve the observed isobars into the components, the normal isobars of the month were copied on tracing paper; these were superposed upon the computed isobars of the given date, and the diagonals were then drawn to form the second system of components. Attention should be fixed upon one characteristic feature in these charts of isobars, which is readily recognized on nearly every map. To the north or northeast of the closed isobars around the low center, there is a cusp-shaped set of isobars forming a saddle between two isobars of the same name; thus, on fig. 19, the cusps 30.0 between isobars 29.9; on fig. 20, 26.4 forms the cusps of a saddle between 26.3; and on fig. 21, 20.2 forms the cusps to 20.1.

By referring to Maxwell's Electricity and Magnetism, Volume I, Plate III, an analogue to this typical construction in electrostatics is to be found; his Plate I is an analogue to a cyclone in relation to the general circulation around the pole, and Plate II is an analogue to an anticyclone. These figures are constructed by the precepts on page 169, so that the resulting isobar is by analogy $B = B_1 + B_2$, where B_1 refers to the general isobars and B_2 to the local isobars. In the electrostatic analogue the potential is found by the law $V = \frac{e}{r}$, where the successive values 1, 2, 3 are assigned to V , and r is computed from a given value of e . In the case of the isobars, the differences are nearly equal to each other in the general system,









and in the local system the gradients may be taken, for example, about twice as great. Specifically, on the normal charts the pressure difference is $G = 0.1$ inch for about one and three-fifths degrees in latitude, or 180,000 meters, or 112 miles. A vigorous cyclone is formed by superposing about eight circles, with the gradient $G = 0.1$ inch for four-fifths of a degree, or 56 miles. The irregularities arising from the distortion of either typical system give rise to problems on the conditions of cyclones and anticyclones which are of much interest. In the case of electrostatic force we deal with potentials and lines of force; in that of pressure with stream lines and gradients, since in the frictionless upper strata of the atmosphere the lines of motion are parallel to the isobars unless under special dynamic conditions. Now, on Charts 36 and 39, of the Cloud Report, are shown isobars after Teisserenc de Bort, drawn about the pole at the elevations 1500 and 3000 meters, respectively. This corresponds with the system of large circles in the electrostatic analogue. On Charts 30 and 31, of the Barometry Report, giving the normal pressure for the 3500-foot and the 10,000-foot planes, we have constructed the lines accurately for one special area in the general system of isobars, namely, that covering the United States, and these are similar in form to those from Teisserenc de Bort, though numbered differently in the inches on account of changes in the adopted heights. They are drawn as perfectly as possible and may be trusted to represent the result of eliminating the local cyclonic circulations.

The maps of pressure and temperature given as Charts VIII and IX of the MONTHLY WEATHER REVIEWS for January and February, 1903, agree closely together in their curvature relative to the pole. By comparing with these high level isobars and isotherms the wind directions determined for the upper cloud system, as shown on Charts 20 to 35 of the Cloud Report, it is possible to infer that the stream lines of the general circulation are parallel to the lines of equal pressure and temperature in the higher strata of the atmosphere. The divergences from this system, which occur at any place, are, therefore, not due to the action of the forces of sliding friction such as produce eddies, but to the interplay of dynamic forces of motion derived from other sources. Furthermore, it is simpler to determine the direction of these common lines, the isobars, isotherms, and vectors of motion in the upper atmosphere by computing the isobars and isotherms from the surface data than by the laborious compilation of wind directions and velocities by means of cloud observations, from which the results may be deduced. That is to say, we may have daily stream lines on the upper planes by computation from surface data, which are as reliable as those which would be obtained from a long series of cloud observations reduced to annual or monthly means. This is a practical conclusion of much value in meteorology. The isobars on Charts 37, 38, 39, 40 of the Cloud Report, from the data of Teisserenc de Bort, show that there is a greater density of the gradient lines from latitudes 25° to 60° , than nearer the equator or the poles. Therefore the pressure gradient is stronger over the United States than in the tropical or in the polar zones. Such a diminution of the general gradient in lower latitudes is in accord with that theory of the general circulation which drives the currents westward in the lower strata of the Tropics; in the higher latitudes the decrease in gradient indicates a feeble tendency to form a belt of winds flowing westward near the pole. It is a tendency only, because the gradient does not reverse but continues to diminish to the pole, and the motion is everywhere eastward. This is another fact in contradiction to the canal theory, and it also implies that the return circulation of cold air from the poles to the Tropics sets in near the latitudes of 50° to 60° in the descending anticyclonic structure, where the cold streams originate in connection with local areas of high pressure, rather than in the polar zone. The cyclones and anticyclones in

middle latitudes are the natural products of the thermal interchange of heat between the "sources" which are in the warm currents and the "sinks" which are in the cold currents. This is not brought about through cooling a northward current in the highest strata of the atmosphere by its radiation of heat into space, or by vertical expansion in the Tropics, as the canal theory requires. The hot and cold masses of air, so far as they are produced by the differences of insolation in the lower layers of the atmosphere, are brought together into physical contact through the low level countercurrents, which are the winds from the south and from the north, respectively. These currents of different temperatures form the natural equivalents to the boiler and the condenser in a thermal engine, and the Carnot cycle is applicable to the analysis of the cyclic processes. The stream lines observed in the motions of the atmosphere as local circulations are built up by the struggle there going on to restore the thermal equilibrium and uniform temperatures. This countercurrent theory is an effective one, in that it brings the abnormal temperatures of the atmosphere into contact through the streams of different temperature, so that they can work mechanically upon one another. The canal theory keeps the currents separated throughout the entire circuit, so that the assumed cooling and heating in the circuit is more like the local heating of a closed current at one portion, while it cools in traveling through the remainder of its course. There is little mechanical efficiency in that process, and it is not useful as a meteorological theory, nor in accordance with the facts of observation.

A certain average excess of heat in the Tropics is required to keep the general cyclone moving at its observed rate of gyration in the upper strata. The thermal equator of such motion moves annually in latitude northward and southward, and this carries with it the entire thermal engine in its annually changing configuration. In the northern winter the thermal equator is far to the south, the contrast between the north polar cold and the tropical heat is much increased, and the general cyclone is relatively efficient; in the northern summer the thermal equator is far to the north, the difference of temperature between the boiler and the condenser of the northern engine is less, so that the circulation is relatively feeble. This oscillation of the heat energy northward and southward, carrying with it the thermal structure toward one pole or the other, just as the astronomical zones of day and night move up and down the earth in latitude, is depicted in the series of diagrams of normal pressure shown in Charts 28 to 31 of the Barometry Report.

The corresponding variations of the temperatures are given on Charts 18, 19, 20, and of the vapor tensions on Charts 23, 24, 25 of the same report. The functions of B , t , e , which are involved in these variations, constitute the basis for a complete solution of the forces that generate and maintain the general circulation in middle latitudes. If we could extend this system of pressure and temperature charts to the pole, and to the equator on the American Continent, and also obtain the vectors of motion, it would afford the required data for the discussion of the dynamics involved in the circulation of the entire atmosphere, and this is the ultimate problem of our meteorology.

The variations of this general circulation from season to season should be extended to include its average changes from year to year, and also the connection of these with that part of the solar energy which is expended as radiation, and is variable in long and short cycles. This will form a science of cosmical meteorology upon which long range forecasting of the seasons can be based. Unless the subject proves to be too complex for human skill to classify, we shall eventually construct a meteorology rivaling other branches of astrophysics in interest and value to mankind.

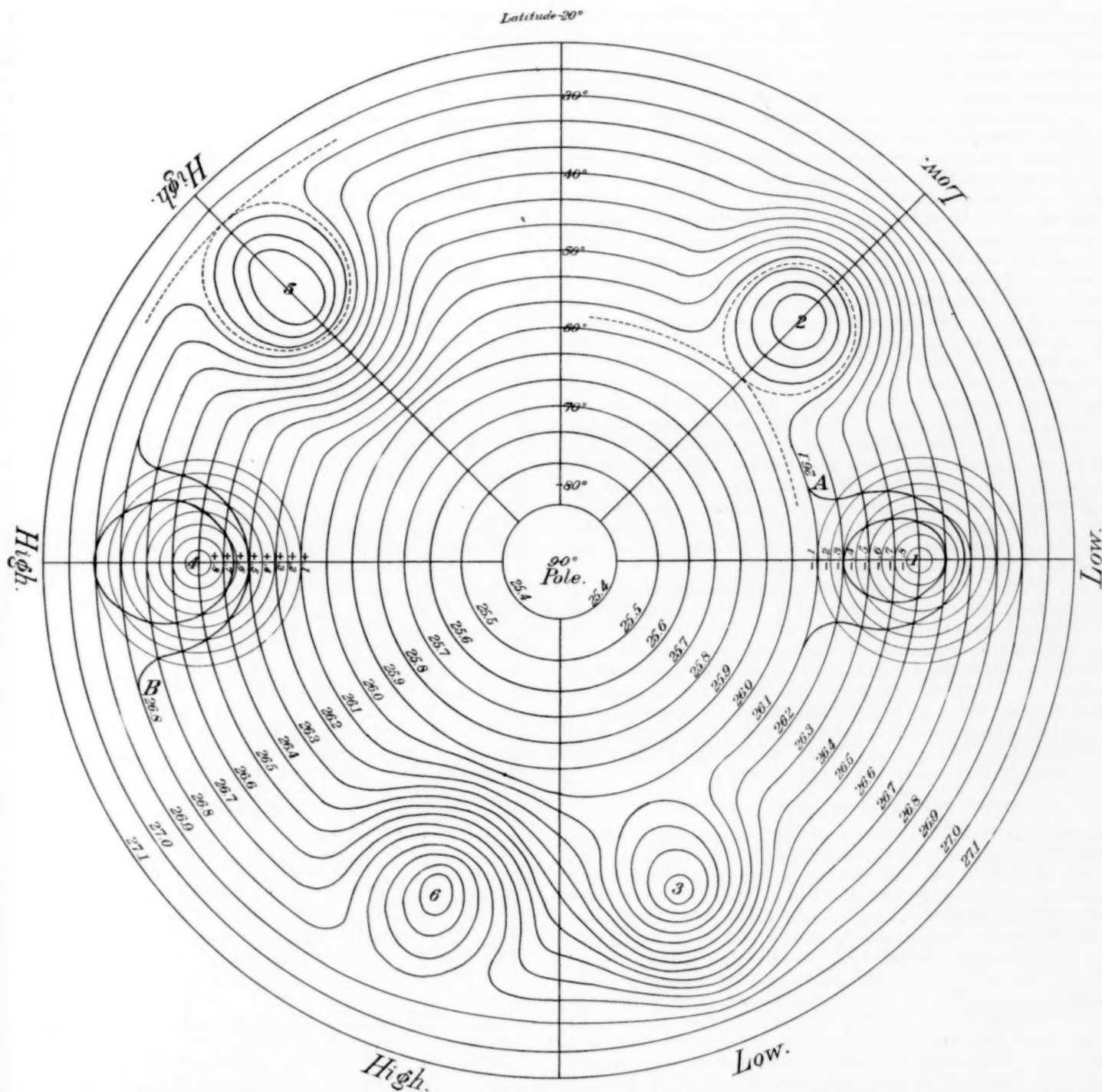


FIG. 25.—The formation of local anticyclones and cyclones in the general circulation about the poles.

THE MECHANISM IN CYCLONES AND ANTICYCLONES.

Turning now from these considerations regarding the general circulation to the mechanism of local circulations, we will further illustrate the separation of the local components from the general normal isobars by the six diagrams of fig. 25, the formation of local anticyclones and cyclones in the general circulation about the pole. We draw 18 concentric circles about a pole as a center, where the common difference is 5 millimeters, except in the polar zone where the difference is greater. The outer circle extends to latitude 23° , that is to Havana, so that these circles cover the latitudes in which the cyclones are produced in northern latitudes. Diagrams 1, 2, 3, show the method of constructing a low pressure area, and 4, 5, 6, that for a high pressure area; diagrams 1 and 4 give examples of the draw-

ing of a few individual resultant curves; 2 and 5 are complete for isolated low and high areas; 3 and 6 exhibit the connection between a high and a low area, and this diagram is comparable with the isobars found on the charts of reduced pressures, as figs. 13, 14, 15, 16, 17, 18, of this paper. In making these specimen diagrams a system of local circles is superposed upon the general circles, but the common difference between them is taken half as much linearly, that is the gradient is twice as steep. On the general circles 5 millimeters is equivalent to 0.10 inch of pressure, on the small circles 2.5 millimeters is equivalent to 0.10 inch of pressure. These relative dimensions serve approximately to illustrate a strong winter cyclone, but they should be modified according to the observed conditions of the individual cyclone. When the monthly normal isobars are subtracted from the observed map of a given day, we

have at once the small circular system, together with its variations from the normal type according to the prevailing circumstances. Looking at diagram 1, of fig. 25, we see that in passing from the pole outward each circle is $+0.10$, one-tenth inch higher, beginning for example with 25.4 and extending to 27.1. The small circles are numbered $-.1, -.2, -.3, \dots$ for the low area, and $+.1, +.2, +.3, \dots$ for the high area. At the point *A* we have 26.1 on the large circle; on the next circle it becomes, $26.2 - 0.1 = 26.1$, by uniting the two gradients; on the next it is, $26.3 - 0.2 = 26.1$. In this way, drawing the diagonal lines, we pass around a U-shaped curve having a certain concavity. Other curves are formed outside and inside of it, a few of the inner curves making closed ovals, eccentric to the center. The dotted curve on diagram 2 shows where the cusp-shaped curves unite over the saddle of higher pressure. The diagrams 4 and 5 are drawn in a similar way, by using the plus system of circles. At *B* we have $26.7 + 0.1 = 26.8$; $26.6 + 0.2 = 26.8$; $26.5 + 0.3 = 26.8 \dots$ Similarly the other lines are drawn. Finally, in diagrams 3 and 6 the two systems are united, so that the lines flow from one to the other continuously. It should be noted that in fixing the centers of the two systems of component coaxial circles, that for diagram 3 was placed on the isobar 26.5, and that for diagram 6 on the isobar 26.4. That is to say, the center of the anticyclone must be nearer the pole than that of the cyclone, in order to make the isobars continuous, otherwise some of the ends of these systems of high and low areas are left unconnected and without natural continuity.

A comparison of these typical isobars with those constructed from the daily observations, see figs. 1 to 24, proves conclusively that they are substantially of the same type. We find the cusp formation on each with the opening of the U-shaped figure toward the pole in the cyclone, but toward the equator in the anticyclone. The closed curves of the cyclone are more nearly elliptical than those of the anticyclone, as is commonly the case on the weather maps. The flow of air from the northern quadrants of the anticyclone toward the southern quadrants of the cyclone is necessary to the structure.

COMPARISON WITH OTHER OBSERVED CONFIGURATIONS.

In order to recall the results of the research which are included in the Cloud Report, the following drawings are introduced. Fig. 26 shows the vectors of motion and their components as observed in anticyclones and cyclones at the 1000 meter (3280-foot) level, and the 3000 meter (9843-foot) level, so that these are comparable with the isobars computed on the 3500-foot and the 10,000-foot planes. The direction of the original vectors is evidently parallel to the isobars, the long vectors which indicate greater velocity are to the north of the anticyclone where the isobars are closer, and then to the south of the cyclone where the closeness of the pressure lines is a maximum. Comparing the anticyclonic and cyclonic components with the resolved local isobars on the charts of observed pressures, figs. 1 to 24, the opening of the stream lines marked *A* on the cyclone corresponds with the opening in the U-shaped clone, similar conditions are found to the south of the anticyclones. Furthermore, in fig. 27, I, II, III, three charts are reproduced from the Cloud Report; Chart 23, the mean winter Lake region low; Chart 29, the mean west Gulf low, each for the lower clouds; and Chart 35, the mean summer hurricane low for the upper clouds. The stream lines flow uninterruptedly to the center on spiral or disturbed spiral curves, one stream from the northwest and another from the south, and to the north of the center the same U-shaped cusp formation is described by the vectors of motion as are found on the charts of isobars. It is remarkable that in the case of the hurricane this formation is found in the cirrus levels, just such as in ordinary cyclones is produced in the cumulus levels, showing that this fundamental typical construction penetrates to the height of 5 or

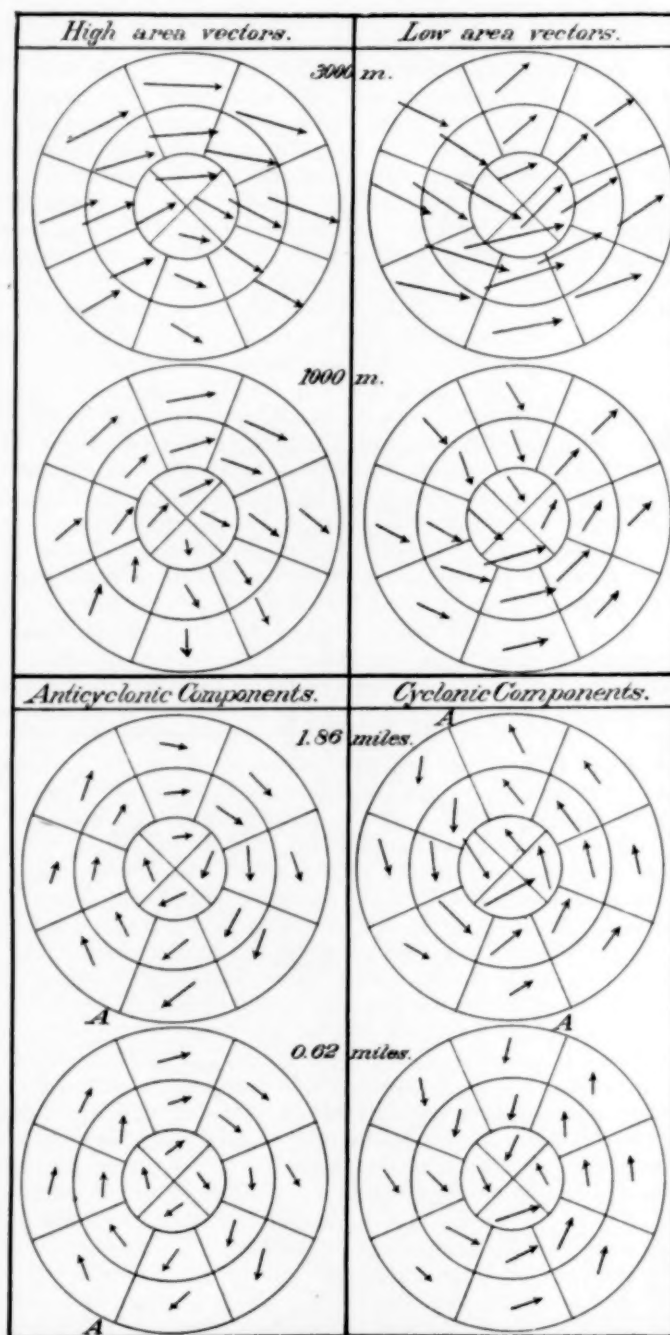
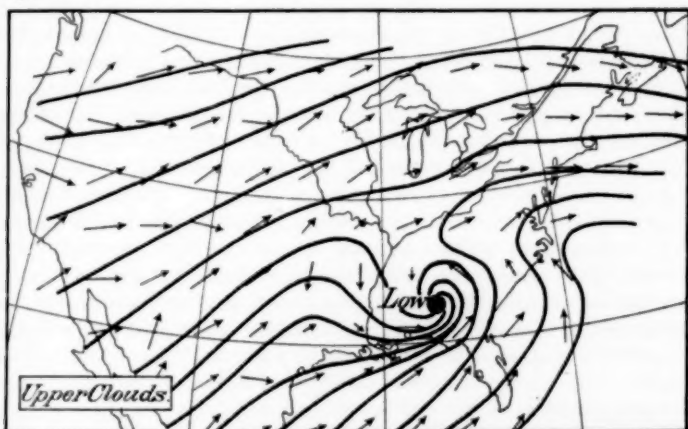


FIG. 26.—The vectors of motion and their components in anticyclones and cyclones at the 1000-mile and 3000-mile levels.

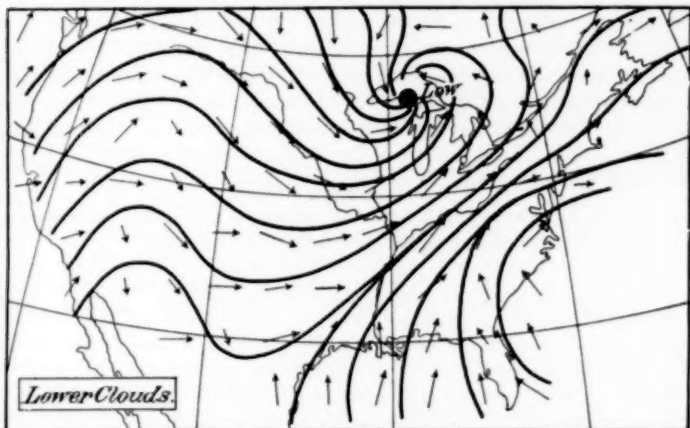
6 miles, when the forces of motion producing it are sufficiently intense. The relative penetrating power of the cyclonic action is a very important feature, which is brought out by these isobars and stream lines in the higher levels.

Furthermore, consider the component local isobars in dotted lines on figs. 4, 5, 6, for January 2; 10, 11, 12, for January 7; 22, 23, 24, for February 27. On January 2 it is evident that the principal feeder is a current of warm air flowing over the South Atlantic States, which curls into the closed isobars from the northward; here the cusp formation is somewhat obscure, and this usually happens while the center is so far to the south. On January 7 the main stream feeds into the vortex from the northwest, and on the western and southern sides, where the isobars are dense, the stream curls into the center. On February 27 there is a strong stream from the southeast and another from the northwest, both of which curl strongly into the central vortex.

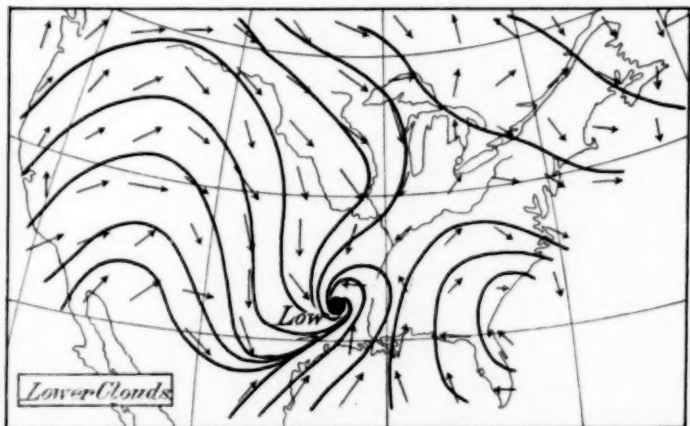
It should be particularly noted that the stream curls into the central vortex at all levels from the ground upward, crossing the closed isobars at some angle, but running parallel to the open isobars, thus confirming the results of the Cloud Report.



III.—Summer hurricane low. Chart 35, International Cloud Report.



II.—Winter west Gulf low. Chart 29, International Cloud Report.



I.—Winter Lake region low. Chart 23, International Cloud Report.

FIG. 27.—The stream lines in cyclones and the cirrus levels in hurricanes.

It should be observed, also, that the U-shaped opening in the northern cyclones is swung around to the northeastward, thus distorting the lines from their primary position of symmetry, which is toward the pole. This is due to the fact that the cyclone has vertical and gyratory components which penetrate from lower to higher levels, and therefore into the upper layers, drifting more rapidly eastward than the lower. Such distortion is accompanied by an interchange of the inertia of motion, and this is the part of the thermal machine

of the atmospheric circulation which acts as a brake upon the swiftly flowing eastward drift. This is the means by which the eastward velocities are slowed down from the excessive motions required, in the general theory by the law of the preservation of vortex areas, into the moderate motions actually observed. Since this penetrating power may extend to the cirrus levels, the total energy of retardation is evidently very great, and therefore this portion of the problem of the general circulation should be developed on the lines already outlined in my papers, rather than on those followed by Professor Ferrel. Furthermore, we remark that my construction is not in accord with the theory of the German vortex, as also explained in that report. This vortex requires a local center of heat and a vertical current, with zero velocity at the center and maximum velocity at a circle on the edge of the closed curves, from which locus it gradually falls away to zero again at a considerable distance. In nature we have, on the other hand, individual stream lines of different temperatures curling into a common center, with velocity increasing up to the very center, as indicated on Chart 69 of the Cloud Report. The German vortex is much nearer the natural type than the Ferrel vortex, but there are features in it which are not compatible with the observations themselves. The disturbance of the eastward drift by the penetration of a cyclonic vortex into the upper strata is further illustrated by the scheme of fig. 28, where the successive levels are

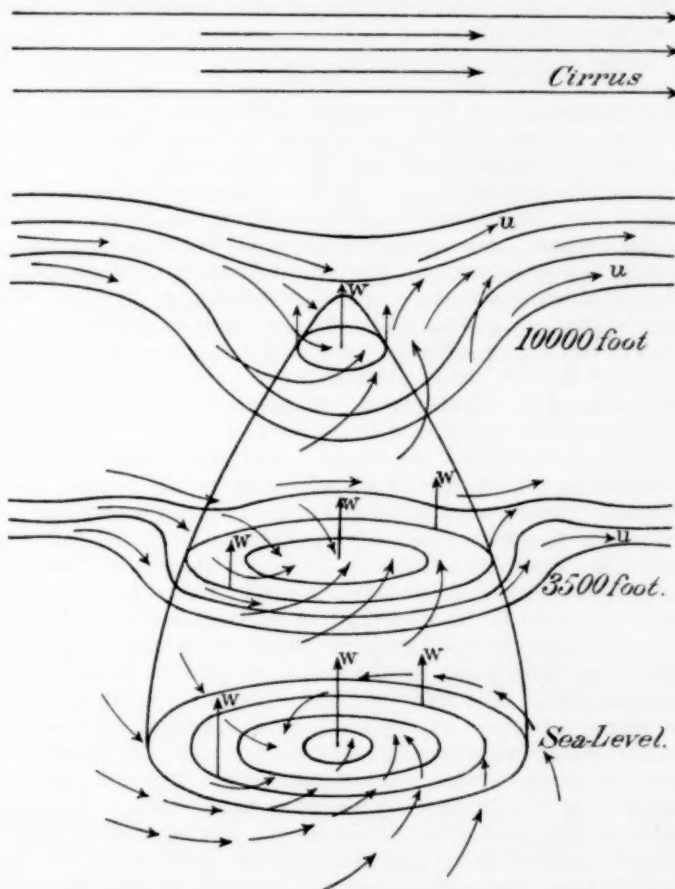


FIG. 28.—Scheme of the disturbance of the eastward drift by the penetration of a cyclone vortex into the upper strata.

shown with the isobars bending away from their normal eastward direction, first into U-shaped curves about the axis, then to cusps and closed curves, and finally to simple closed curves at the surface. These closed curves always imply a vortex with its vertical component governed by the usual vortex laws. The boundary of the true vortex action diminishes in size, and loses itself in the upper strata as a simple sinuous deflection. The vortex throws up a vertical component all over its area in

proportion to the gyratory velocity, and in the center this forms a rising current, continuous and undisturbed, till high levels are attained. On the edges, however, the vertical component is stripped off by the action of the eastward drift, which also acts more powerfully in proportion to the elevation. This depletion of the surface of the vortex in proportion to the height is the mechanical mode that controls the escape of the upward current, which loses itself to the eastward by merging in the general circulation, whence it passes through other anticyclones and cyclones in succession. The radial horizontal component is inward toward the center in all levels of the cyclone, as was indicated in my Cloud Report. Thus, the entire complex of the circulation has dynamic components, and the energy thus expended must be referred back finally to the source of heat in the Tropics, where the absorption of radiant energy from the sun goes on vigorously at the surface of the earth. The great general cyclone is perpetuated by the vertical uplift of the strata, due to the residue of the tropical heat which does not leak out toward the poles in horizontal warm currents of air near the surface, and its motion is in general nearly independent of the counterflow of these lower currents, except for the distortion due to the penetration just described. We have therefore established the existence in the cyclone of the interaction of three practically independent currents of air, (1) the great overflowing eastward drift, (2) the underflowing cold current from the northwest, and (3) the underflowing warm stream from the south.

THE INTERACTION OF THE THREE THERMAL CURRENTS.

It is necessary yet further to consider the thermal action of these currents which have very different temperatures. For it is evident that the formation of local closed isobars with vortex action and vertical currents, while accompanied by dynamic forces must yet depend upon a powerful and persistent thermal source. We have elsewhere shown that this energy is not to any great extent the latent heat of condensation of aqueous vapor, this being a secondary product; nor is the effect purely dynamic as the eddy theory implies. Where, then, shall we find a true efficient source of heat that is competent to account for all the conditions observed in the circulation phenomena of the atmosphere. It seems to me that this is to be attributed to the *thermal action due to the overflow of layers of cold air upon masses of warm air*. Abnormal stratification of air currents, where the relatively cold is above the warm, necessarily involves an upward current having an energy proportional to the difference of temperature. It is not necessary to say more about the truth of the view that this stratification exists, because such an overflow is really one of the most common conditions to be observed in meteorology. If a warm current leaves the latitudes of the high pressure belt, 35° more or less, and runs northward, it begins to underflow the eastward drift. If a cold area slides down from the northwest into warm latitudes, its upper portions are drifted forward over the warm lower strata. If two currents counterflow together the cold western masses are drifted forward upon the warmer at moderate levels, also warm masses are carried eastward over the next anticyclonic area. The instant the normal thermal equilibrium of the atmosphere is disturbed by such stratifications, thermal energy is present for the formation of dynamic vortices. Thus a hurricane begins in the late summer when the sun retreating southward brings the first layers of cool air to overspread the Tropics in a sheet. The warm surface air then begins to flow under this and penetrates it in a vortex, and this continues to operate as long as the flow of current sheets of two temperatures from the different sources continues. The track of a hurricane can thus traverse thousands of miles, because the cold overflow sheet covers the temperate zone, and the warm underflow current is directed in streams depending upon the general circulation of the lower

air about the permanent anticyclonic centers of action. A specific example will make these remarks more definite.

In the Cloud Report we took great pains to construct the abnormal gradients of pressure, temperature, and vapor tension, such as are observed when the cumulus clouds are in the process of formation. These gradients are to be found in Tables 147, I to VII, for the metric system, and in Tables 153, I to VII, for the English system. By entering these tables with the prescribed arguments we can find the gradients which are prevailing at a given level in a cyclonic circulation. These tables are constructed primarily in reference to the 3500-foot plane, but they can be extended to other levels by the adjoining precepts, if some judgment is exercised. Furthermore, it was essential to establish the normal conditions which prevail in the atmosphere at two higher planes, so that the difference between the normal gradients, which may be readily computed from the mean monthly values as given in the Barometry Report, and the abnormal gradients, which pertain to the different subareas of cyclones and anticyclones, may be obtained. This was one of the purposes that was kept in mind in constructing the Barometry Report, and the data for such normal gradients are given in Table 48. By subtracting the numerical values for B , t , e , on the different planes, and dividing by the difference in elevation, these normal gradients are found. By using the surface data in connection with the three selected planes, we obtain several systems of gradients which can thus be computed for mutual comparison. As to the abnormal gradients of temperature, for example, we may take from Table 153, II, of the Cloud Report, the values for the different subareas in a cyclone, the table being quoted only in part.

TABLE 1.—Pressure and temperature gradients in English measures.
FALL OF PRESSURE IN INCHES PER 100 FEET.

e B	.0100	.0120	.0140	.0160	.0180	.0200	.0220	.0240
t ° F.								
90			0.095	0.095	0.095	0.096	0.096	0.097
80		0.096	.097	.097	.097	.097	.098	.099
70	0.098	.099	.100	.100	.101	.102	.102	.103
60	.102	.103	.104	.104	.105	.106	.107	.108
50	.105	.106	.107	.107	.108	.109	.110	
40	.107	.108	.109	.109	.110	.111		
30	.109	.110	.111	.111	.112			
20	.113	.114	.115	.115				
10	.117	.118						
0	.120							

FALL OF TEMPERATURE IN DEGREES PER 100 FEET.

e B	.0100	.0120	.0140	.0160	.0180	.0200	.0220	.0240
t ° F.								
90					0.88	0.82	0.74	0.240
80		0.85	0.82	0.74	.65	.58	.52	.47
70	0.79	.68	.59	.51	.43	.37	.34	.31
60	.59	.48	.40	.33	.30	.28	.27	
50	.41	.33	.25	.20				
40	.26							

From Table 153, International Cloud Report.

In the eastern subareas we have high temperatures and high vapor tensions (t_1, e_1) so that the temperature gradients are large; in the western areas the temperatures and also the vapor tensions are lower (t_2, e_2). Then (t_1, e_1) will give larger values of $G. t_1$ than (t_2, e_2) will give for $G. t_2$. If the $G. t_1$ exceeds the normal gradient of the season, we have the mechanical cause for a vertical current. This principle can be applied throughout the cyclonic field with unfailing results of the right kind. In general it may be stated that the normal temperature gradients are about three-fifths the adiabatic rate, and this occurs

when the strata are in atmospheric equilibrium and no currents are distinctly rising or falling. In cyclones and anticyclones, where the vertical currents are pronounced, the temperature gradients are about the same as the adiabatic rate. This remarkable theorem regarding gradients is very significant in the physical thermodynamics of the atmosphere. Hence, we conclude that air is rising to the east, but falling to the west of the center of the cyclone. It seems almost a paradox that in the warm current of air the air should be rising to a region where the pressure is higher than it was before the movement began. But rising air always increases the pressure in the stratum to which it is moving, and this hardly needs to be reaffirmed. The overflowing cold air in the strato-cumulus level, therefore, in itself generates the power which raises the warm air underneath it by the usual thermodynamic laws. Hence, if a relatively cold layer is thrust into a column of air otherwise normally disposed, the warm lower layers will rise to meet the cold stratum, and the higher strata which are also relatively warm will fall toward it. Relatively warm air flows to the place of relatively cold air. If the surface layers are cooled by radiation in anticyclones the air of the upper strata will settle down upon them by this law, namely, that relatively warm air seeks relatively cold air. The currents of transfer thus set up have an adiabatic system of gradients; on the other hand, the normal layers of the atmosphere do not dispose themselves into adiabatic strata, as was proved in my Cloud Report. Some specific examples of the operation of these processes will now be mentioned.

EXAMPLES OF THE INTERACTION OF ABNORMALLY COLD AND WARM STRATA.

A survey of the conditions prevailing at the time of the waterspout photographed on August 19, 1896, off Cottage City, in Vineyard Sound, Mass., leads me to the results contained in Table 2, extracted from a report now in preparation on this important phenomenon. It contains for the α , β , γ , δ stages the heights on the photograph in millimeters and inches, the actual height in meters and feet, and the pressure, temperature, and vapor tension at the beginning and end of each stage.

Thence the gradients are found per 100 meters, or per 100 feet, viz: (1) (G_o) Observed, according to the actual observations, (2) (G_c) Cloud, according to the Cloud Report Tables 147 and 153, and (3) (G_b) Barometry, the normal gradient prevailing in the air for that month as deduced from Table 48 of the Barometry Report. This waterspout was formed under remarkable conditions. The pressure was a little high, 30.05 inches; the temperature was exactly normal for the month of August, 67.5° F., and the vapor tension was low, corresponding to a relative humidity of 64 per cent. This gives the ratio $\frac{e}{B} = 0.0143$ from which the gradients (G_c), cloud, were obtained. Comparing (G_o), (G_c), and (G_b) we note that (G_b) is less than (G_o) and (G_c) in both the pressure and the temperature, but greater in the vapor tension for both the α and β stages. This waterspout was formed in a congested region on the southeast edge of a great area of high pressure, which was pushing over the New England coast line at that time, and there was no cyclonic action of any kind. There was then generated a rapid formation of cumulo-nimbus clouds, with rainfall at the front, waterspouts in the middle, and thunderstorms with hail following, all in the course of a couple of hours. I conceive that this entire set of phenomena was due to the drifting forward (in the strato-cumulus level) of the relatively cold air of the anticyclone as a sheet overspreading the quiet layers of relatively warm air resting on the ocean. The normal temperature at the ocean level is 67.7° F. for August, and 60.4° at the 3500-foot level. But by computation the temperature was 48.7° at that level, giving an abnormal fall of 11.7° F., due to the overflowing of the cold stratum from the advancing anticyclone. This great fall in temperature was not caused by any change in the surface conditions, which remained normal till the thunderstorm following the rain and waterspouts brought the cold air to the surface and caused the temperature to fall at the ocean also. The cold upper stratum evidently preceded the surface cold air by several hours, and this is typical of the conditions frequently prevailing in similar local congested circulations of the lower strata, where abnormal stratification and so-called inversion of temperature is observed. This ab-

TABLE 2.—Summary of the data for the Cottage City waterspout, August 19, 1896.

Stages.	Metric system.					English system.					
	H. photo.	Height.	R.	t.	e.	H. photo.	Height.	R.	t.	e.	
	<i>Mm.</i>	<i>Meters.</i>	<i>Mm.</i>	<i>°C.</i>	<i>Mm.</i>	<i>Inches.</i>	<i>Feet.</i>	<i>Inches.</i>	<i>°F.</i>	<i>Inch.</i>	
	176.4	4,942	414.5	-12.0	1.64	6.95	16,214	16.32	10.4	0.065	
δ -stage	73.6	2,062	-6.04	-0.582	-0.142	2.90	6,765	-0.072	-0.319	-0.00170	(G_o) Observed.
			-6.50	-0.550	-0.140			-0.078	-0.302	-0.00168	(G_c) Cloud.
	102.8	2,880	539.0	0	4.57	4.05	9,449	21.22	32.0	0.180	
γ -stage	2.6	74	-6.76	.....	.....	0.10	243	-0.082	.....	.....
	100.2	2,806	544.0	0	4.57	3.95	9,206	21.42	32.0	0.180	
β -stage	61.7	1,728	-7.40	-0.538	-0.240	2.43	5,669	-0.089	-0.294	-0.00288	(G_o) Observed.
			-7.60	-0.540	-0.260			-0.091	-0.294	-0.00312	(G_c) Cloud.
			-7.11	-0.376	-0.364			-0.085	-0.207	-0.00437	(G_b) Barometry.
	38.5	1,078	672.0	9.3	8.72	1.52	3,537	26.46	48.7	0.343	
α -stage	38.5	1,078	-8.46	-0.963	-0.204	1.52	3,537	-0.101	-0.531	-0.00246	(G_o) Observed.
			-8.40	-0.950	-0.192			-0.101	-0.522	-0.00230	(G_c) Cloud.
			-8.24	-0.375	-0.296			-0.098	-0.206	-0.00355	(G_b) Barometry.
Sea level ..	0	0	763.27	19.72	10.92	0	0	30.05	67.5	0.430	

normal stratification of cold over warm layers caused the thermal difference necessary to enable the hydrostatic pressure of the neighboring region to cause a vertical current. In this rising air the temperature and pressure gradients changed from the normal rates prevailing previous to the sudden change into adiabatic rates, which seem to have been fully reached in the temperature. There are numerous physical functions useful in meteorology involved in these data, and it will be valuable to compute the B , t , e in the higher strata for as many instances of the kind as is practicable.

Some idea of the energy available to produce a vertical current can be gained from the following consideration: The normal temperature gradient in the α -stage is -0.206 per 100 feet, the observed gradient is -0.531 , and this is a gain of -0.325 . The normal pressure gradient is -0.098 per 100 feet, the observed gradient is -0.101 , and the gain is -0.003 per 100 feet, or 0.106 inch in the α -stage. That would be equivalent to the enormous gradient of -13.5 inches in a degree, $111,111$ meters, along the surface of the earth, which is 100 times as great as that observed for the usual horizontal gradients. In the β -stage the temperature normal gradient is -0.207 , the observed is -0.294 , the increase -0.087 per 100 feet. Comparing this with -0.325 , the increase in the α -stage, we conclude that the efficient buoyancy gradient is four times greater in the α -stage than in the β -stage. This is contrary to what should be expected if the buoyancy is chiefly due to the condensation of aqueous vapor to water in the cloud or β -stage, but it is in accord with the theory of stratification proposed in this paper.

We have other examples of the effect of an overflow of a cold stratum upon the warm air of lower levels in the numerous cases where anticyclonic areas advance into the central valleys from the northwest without a cyclonic development in front of them. There is produced in such conditions a wide band of rainfall on the map, stretching from the Lake region to the Gulf of Mexico, where no dynamic action is operating which can raise the air mechanically. The cold, overflowing sheet will, however, cause an increase in the temperature gradient, and this is accompanied by rising air and precipitation over immense areas of country. In certain cases the anticyclonic area will advance to the Atlantic coast before causing such ascending currents, and then a powerful small cyclone sometimes develops suddenly near the coast of New Jersey or Virginia, and as this advances to New England it produces hurricane winds. When two currents of different temperatures flow together in the Mississippi Valley the overflow of the cold layers from the northwest upon the warm layers from the south produces a congested condition, accompanied by thunderstorms, tornadoes, and general violent local circulations in the southeastern quadrants of the cyclone. On the other hand, the wide range in temperature required to cause such rapid vertical circulations may also be produced by simply overheating the surface layers relatively to the upper strata. This is the case in summer, when in anticyclonic areas the solar radiation passes through all the upper layers to the surface without heating them sensibly. Then the earth's radiation, in its turn, does have the power to overheat the lower strata, and this causes an increased temperature gradient relatively to the cumulus levels, which is the atmospheric condition for numerous summer thunderstorms and desert sand squalls. In the winter the areas of low pressure over the northern portions of the Atlantic and Pacific oceans are due to the relatively high temperature of the ocean waters and adjacent air layers. During the months in which the lower layers are too warm in comparison with the adjacent continental areas and with the strata above them, the well-known permanent cyclones prevail. The reverse case occurs in sum-

mer over the ocean belts at the boundary of the tropical and the temperate zones, where the water holds the surface strata at temperatures lower than is required for equilibrium, and so causes a settling down of the upper air. This is, of course, an effect which increases the usual dynamic action produced by the general circulation in this high pressure belt.

In the autumn the cold layers advance from the northern zones into the Tropics, first in the higher strata which over-spread the warm and moist air of the doldrums. This causes an increase of the vertical temperature gradient, and a hurricane or large columnar vortex is formed, through whose structure the warm air pours upward to great heights, and enables this configuration in some cases to perpetuate itself by such convection for many days. It is the wide spread cold sheet of the upper strata which is the persistent source of energy in a hurricane, and also in a cyclone. The advancing movement of the center is due to the fact that the warm air, which lies to the eastward, promptly rises to meet the overflowing cold sheet, the two mutually sustaining each other's action. The downflow of the cold air on the western side is simultaneous with the upflow on the eastern side, but the deficiency of pressure on one side and the excess of it on the other by its continuous operation causes the entire structure to advance. In addition to this, the drift of the upper strata, eastward in the temperate zone and westward in the Tropics, carries along the cyclone, which adheres to them by the interactions that have been described.

GENERAL RESULTS STATED.

The results of this research may be summed up briefly as follows: (1) The cyclone is not formed from the energy of the latent heat of condensation, however much this may strengthen its intensity; it is not an eddy in the eastward drift; but it is caused by the counterflow and overflow of currents of different temperatures. Ferrel's canal theory of the general circulation is not sustained by the observations, nor is his theory of local cyclones and anticyclones tenable. There are difficulties with regard to the German vortex theory, but this is nearer the truth than the Ferrel vortex. The structure in nature is actually more complex than has been admitted in these theoretical discussions, but it doubtless can be worked out successfully along the lines herein indicated. (2) Regarding the relation of the upper level isobars to practical forecasting, it is noted as the result of the examination of the charts of December, 1902, January and February, 1903, that (a) the direction of the advance of the center of the low pressure is controlled by the upper strata, and its track for the following twenty-four hours is usually indicated by the position of the 10,000-foot level isobars; (b) The velocity of the daily motion is also dependent upon and is shown by the density of these high level isobars; (c) the penetrating power of the cyclone is safely inferred from an inspection of the three maps of isobars of the same date; (d) there is decided evidence that areas of precipitation occur where the 3500-foot isobars and the 10,000-foot isobars cross each other at an angle in the neighborhood of 90° ; (e) there have been several cases in which the formation of a new cyclone has been first distinctly shown on the upper system of isobars before penetrating to the surface or making itself evident at the sea level. (3) It is expected that by completing our discussion of the temperature gradients between the surface and the higher levels we shall be able to secure daily isotherms as well as daily isobars on the upper planes, and this will tend to strengthen any further examination of these important problems. A suitable report will be prepared in which the data now coming into our possession will be subjected to a mathematical analysis and discussion.

NOTES AND EXTRACTS.

JAMES GLAISHER.

From *Nature*, February 12, 1903, page 348.

We regret to see the announcement that Mr. James Glaisher died on Saturday, February 7. Born April 7, 1809, he had nearly attained the great age of 94 years, the major portion of which was devoted to unceasing work of a varied nature, mainly, however, directed to practical meteorology.

At the age of 20 he was appointed as assistant on the principal triangulation of the ordinance survey of Ireland, and from 1833 to 1836 was an assistant at Cambridge University, whence he proceeded in the latter year to the Royal Observatory, Greenwich, and having been, in 1840, promoted to the position of superintendent of the magnetical and meteorological department, he remained there until his retirement from official life in 1874.

His contributions on subjects bearing on meteorology and astronomy were too numerous to allow of our giving more than a passing notice. His Hygrometrical Tables, published in 1847, which have reached their eighth edition, are still the standard work on the subject for the British Islands. Travels in the Air (1871 and 1880), Diurnal Range Tables (1867), Mean Temperature of Every Day for Greenwich, 1814-1873, Report on the Meteorology of India, and Meteorology of Palestine are among his chief writings.

From 1862 to 1866 he made twenty-nine balloon ascents in the interests of meteorological science, and the results were given in reports to the British Association at their annual meetings of those years. The ascent on September 5, 1862, is particularly memorable from the fact that he and the late Mr. Coxwell attained the highest distance from the earth (37,000 feet) ever reached, and formed the subjects of a most thrilling experience, which nearly had a tragic termination for both of the intrepid aerial explorers.

As the pioneer of systematic organization of meteorological observations, the results of Glaisher's endeavors may be seen in his weekly, quarterly, and annual reports on the meteorology of England, contained in the periodical returns of the registrar-general of births, deaths, and marriages for England and Wales during the long period of sixty-one years (1841-1902). He was a juror in the class of scientific and philosophical instruments at the exhibitions of 1851 and 1862, and, apart from his scientific work, was actively engaged in other useful spheres of labor.

He was a fellow of several of the learned societies. For upwards of half a century he was on the roll of membership of the Royal Society, to which he was elected on June 7, 1849, and from time to time he contributed papers to the Philosophical Transactions. In 1850 he was one of the founders of the British Meteorological Society, now the Royal Meteorological Society, and for many years took a leading part in the conduct of its affairs, being its original secretary, "who nursed it through its infancy and youth, and left it to other hands only when it was old enough and strong enough to walk alone." (President's address in the jubilee year.) He was also a past president of the Royal Meteorological Society, the Royal Microscopical Society, the Royal Photographic Society, and the Aeronautical Society of Great Britain, a fellow of the Royal Astronomical Society, and for many years was on the executive committee of the Palestine Exploration Fund, of which he was for twelve years the chairman. He had also been honored with the honorary fellowship of several foreign scientific bodies.

SNOW FROM A CLEAR SKY.

The Gazette of February 18, Galena, Ill., contains the following:

A peculiar weather condition prevailed here for a short time last night. Between the hours of 10 and 11 p. m. there was a fall of snow to the depth of one-eighth of an inch and yet the stars were shining all the time. Inasmuch as the snowfall preceded the arrival of the high gale that blew during the latter part of the night, it was probable that the snow had been carried in the air for a long distance and precipitated here.

The rather plausible explanation here given requires special confirmation before it can be accepted. It is equally plausible and more probable that the snow which fell from the clear sky actually formed near the place where it fell. In perfectly still cold weather the Editor has seen snow crystals continue falling during the night until more than one-eighth of an inch had accumulated. In such cases it was evident that the air had cooled to a temperature very near saturation, so that the particles of dust floating in the lower air became the nuclei for the formation of snow crystals. The latter being heavy, slowly descend and doubtless grow as they fall; in fact, there is no known reason why they should not continue growing after they reach the ground, since the crystal is undoubtedly

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colder than the average temperature of the air. Very large snow crystals, sometimes one-half inch in diameter, have been recorded on some occasions.

This deposit of snow from a clear sky, like the fall of rain from a clear sky, may also be due to the cooling of the air at a considerable altitude rather than near the earth's surface, and the cooling may be due to a mixture of cold and warm currents. Such mixtures, as is well known, can not form heavy rainfalls, but may produce the slight amount of precipitation implied in this snowfall from a clear sky at Galena, where a few hours later in the night the temperature fell to -17° and to -23° , with a heavy gale.

SUNSHINE RECORDS AT HAMBURG, GERMANY.

The German meteorological observations for 1901, at stations reporting to the Deutsche Seewarte for the year 1901, has lately been published. In addition to the monthly summary for each station and the hourly readings from self-registers at four normal stations, this volume gives complete statistics of the weather on stormy days on the German coast. The appendices give the details of the duration of sunshine at Hamburg and the tables of contents of the annual volumes published by the official meteorological services of Baden, Bavaria, Prussia, Saxony, Wurtemberg and Alsace-Lorraine, and by the private services at Magdeburg, Bremen, Wiesbaden, Frankfurt on Main, Aix-la-Chapelle. From the sunshine table for Hamburg, computed by H. Koenig, we take the following abstract:

Months.	Total number of hours.	Percentage of possible sunshine.	Number of days without sunshine.
January.....	67.5	27.1	9
February.....	56.4	20.7	10
March.....	46.0	12.6	12
April.....	160.0	38.4	5
May.....	196.9	40.0	2
June.....	126.3	25.0	2
July.....	190.3	37.5	4
August.....	177.9	39.0	2
September.....	164.4	43.2	7
October.....	62.7	19.2	13
November.....	41.0	16.0	15
December.....	13.2	5.7	22
Total annual.....	1302.6	29.1	103

The hourly distribution of sunshine is given in hours only, without the corresponding percentage of total possible, and is as follows:

Local time.	Total annual duration.	Local time.	Total annual duration.
<i>Hours.</i>		<i>Hours.</i>	
5 a. m. to 6 a. m.....	2.9	2 p. m. to 3 p. m.....	139.7
6 a. m. to 7 a. m.....	16.9	3 p. m. to 4 p. m.....	123.5
7 a. m. to 8 a. m.....	35.8	4 p. m. to 5 p. m.....	100.8
8 a. m. to 9 a. m.....	73.8	5 p. m. to 6 p. m.....	78.2
9 a. m. to 10 a. m.....	102.7	6 p. m. to 7 p. m.....	43.7
10 a. m. to 11 a. m.....	127.4	7 p. m. to 8 p. m.....	3.4
11 a. m. to 12 noon.....	137.8		
12 noon to 1 p. m.....	155.2	Total 5 a. m. to 8 p. m..	1302.6
1 p. m. to 2 p. m.....	160.8		

The month of greatest total amount of sunshine is May and the month of the greatest percentage of total possible sunshine is September. The hour of the greatest absolute amount of sunshine is from 1 to 2 p. m. for the annual total, but varies between 10 a. m. and 4 p. m. in the different months.

AERIAL RESEARCH IN DENMARK.

M. Leon Teisserenc de Bort presented a communication upon the use of kites and sounding balloons as practised at Viborg (Denmark) by the Franco-Scandinavian committee.

The object of this enterprise is to study, in as continuous a manner as possible, during a certain number of months, the variations of the meteorological elements in the middle strata of the atmosphere. The loca-

tion of the station has been carefully chosen; it is situated upon an extensive and desert plateau, near Hald, 11 kilometers south-southwest from Viborg, sufficiently distant from the sea and on one of the three routes ordinarily followed by the barometric depressions in this part of Europe. An extensive Danish landed proprietor, Jagdmeister Krabbe, has kindly cooperated with this scientific undertaking by placing the ground at the disposal of the committee and by directing the construction of the wooden buildings.

The regular observations began at the beginning of August, 1902; they will probably terminate during the month of April, 1903. During the fine season, strong winds below and relatively feeble winds above were frequently observed, a condition not very favorable to the sending up of kites. This regimen which is a characteristic of high pressures prevails for all directions of wind. From observations made in Berlin Berson had believed that this is a characteristic peculiar to east winds, and that west winds on the contrary show a rapid increase in velocity with altitude, but, as he himself recognized later, this is only because the east winds in Germany generally coincide with high pressures and the west winds with low pressures.

At the end of September and during October there was observed at Viborg the passage of several depressions of small diameter and rapid movement, which did not probably reach to any very considerable height, but showed all the characteristics of the cyclone, properly so-called, such as the reversal of the wind from the front to the rear, the central calm and even the momentary clearing of the sky, known as the "eye of the storm."

Later on came the great winter depressions accompanied with extremely strong winds. On Christmas day there even occurred a violent tempest which came near destroying the revolving shelter used for sending up the balloons and kites. The anemometer became useless after having registered a velocity of 35 meters, which velocity was certainly exceeded afterwards. According to the inhabitants this tempest was the most violent that has occurred in Denmark, except that of 1872 which inundated several islands.

Certain kite ascensions were distinguished by interesting occurrences; the 15th of August, after a breakage in the line, the string of kites dragged for about 120 kilometers, 80 of which were at sea. Another time, November 11, the kites escaped in a northwesterly direction and were found in Norway.

In regard to the sounding balloons, the proximity of the sea renders special precautions necessary; they are regulated so that the ascension shall not last more than, at most, 15 or 20 minutes, and the altitude attained under these conditions is only from 5000 to 6000 meters.

The meteorographic tracings are made by engraving on copper, by a process that has been made practicable by a new system of metallic pen due to M. Raymond. It suffices to fill the pens with sulphuric acid and to use sheets of copper which are covered with lamp black, in order, as much as possible, to avoid seams. The curves thus obtained are much less delicate than by the ordinary lamp black process, but they have the advantage of being ineffaceable. All reductions and computations are made promptly, and the publication of the results can therefore follow very closely on the termination of the work.—*Annuaire de la Société Météorologique de France, Février, 1903. Pp. 32-34.*

COURSES OF INSTRUCTION.

Among the recent courses of instruction in meteorology and climatology we notice those offered by Dr. J. Paul Goode, Ph.D., instructor in geography in the Wharton School of Economics in the University of Pennsylvania. There is a short course of four hours a week during the first term of the year entitled "Climatology and applications in economic geography." It covers the following subjects:

Principles of meteorology; general atmospheric circulation; laws of storms with special attention to the cyclonic storm; charting of weather elements. Application of principles of meteorology to the interpretation of regional climates. Climate as a factor in economic and social development.

There is also in the course for teachers a series of lectures, occupying one hour, given each Saturday throughout the college year, about forty in all, entitled "The atmosphere and the ocean."

Part 1. Meteorology; the general atmospheric circulation, the laws of storms, the charting of weather elements, and the interpretation of weather maps. Scientific weather forecasting.

Part 2. Oceanography; the principles of oceanic circulation, action of waves and tides, harbors, sailing routes.

Part 3. Climatology; the regional application of the principles of climate to the world at large.

Doctor Goode has recently accepted a position in the depart-

ment of geology of the University of Chicago, and will probably give these same courses at that place next year. It is most important that all teachers should profit by such lectures so that the general public may be educated up to a better appreciation of the difference between the daily weather map with the forecasts of the Weather Bureau and the farmers' almanacs with the forecasts of these astrological editors.

HANN'S CLIMATOLOGY IN ENGLISH.

As we go to press we have the pleasure of being able to announce that the famous *Handbuch der Klimatologie* of Prof. Julius Hann is now accessible to the English-speaking world, in a beautiful edition published by the Macmillan Company of New York and London at the very reasonable price of \$3.

American meteorologists will be proud to accept this epoch-making treatise from the hands of their colleague, Prof. R. DeC. Ward, of Harvard University. He gives us not merely a translation of this admirable work, but a volume that contains so many additions and improvements that, with the consent of the author, it may well be known as a joint work by Ward and Hann. Professor Ward has long been known as the successor of Prof. Wm. M. Davis in building up a most influential school of meteorology at Harvard. From this school many teachers have gone forth to battle for the cause of higher education in this science. A number of these have even published elementary text-books on physical geography, including climatology, and these subjects are now studied in thousands of schools throughout the United States, instead of being totally neglected as was the case when the Weather Bureau began its work over thirty years ago.

By teaching the elements of climatology to the youth of our land, these schools and enthusiastic teachers are laying the sure foundation for the development, here and there, of an interest in the fundamental problems of meteorology which is sure to culminate in the education of many future American investigators and promoters of this science. As the efficiency of the British Navy is said to lie in the fact that the British marine can always furnish trained sailors, so the strength of American science will depend upon the proportion in which all American youths are taught the elementary truths of science. Not every student of physical geography will become a meteorologist, but the probability that many may do so is increased by the diffusion of just such books as this admirable treatise and translation.

It is certainly not too much to say that there is no work on this subject in the English language to be compared with the present volume. Not only are the older treatises by Buchan in England and Loomis in America already quite out of date, but the more recent treatises, about twenty of which are mentioned in the *MONTHLY WEATHER REVIEW* for August, 1902, entirely fail to take the comprehensive view of the subject presented to us in this treatise by Hann. Nearly all of these treatises have a didactic style, oftentimes interesting, but leading the reader to the conclusion that the author's statement must embrace pretty much all that is known on the subject, whereas the present work stimulates the student to further inquiry, and, in fact, by means of numerous references on nearly every page tells him just where he may go for further information. A brief review of these references must impress one with the fact that the great mass of important material in meteorology has been published in French and German, while those who use the English language, although they are indefatigable in observing and publishing, yet fail to apply to nature those methods of study that are necessary in order to secure real advance in knowledge. It must be considered as a very important characteristic of the present work that it brings home to the English reader the results of so much that is published in foreign languages.

ORIGIN OF THE WORD 'BAROMETER.'

The following article, by Dr. H. C. Bolton, is reprinted from *Science*, Vol. XVII, p. 548:

The instrument familiar to us all as the barometer was first universally known by the name of its inventor as 'Torricelli's tube'; de Guericke, the inventor of the air pump, called his huge water-barometer 'Semper Vivum,' also 'Weather Mannikin,' with the Latin form 'Anemoscopium.'

Soon after the year 1665 the words 'baroscope' and 'barometer' came into general use in England, but the individual to whom the credit belongs for originating these terms has not been certainly known; the assertion made by a contributor to the *Edinburgh Review* for 1812 that 'baroscope' was first used by Prof. George Sinclair, of Scotland, in 1668, is an error, for both words occur in the *Philosophical Transactions* four years earlier. The passage is unsigned and reads thus:

"Modern Philosophers, to avoid Circumlocutions, call that Instrument, wherein a Cylinder of Quicksilver, of between 28 and 31 inches in Altitude, is kept suspended after the manner of the Torricellian Experiment, a Barometer or Baroscope, first made publick by that Noble Searcher of Nature, Mr. Boyle, and employed by him and others to detect all the minut variations in the Pressure and Weight of the Air."

The mention of the words in connection with the name of Robert Boyle has led me to make a close examination of his voluminous and prolix writings. In Boyle's first publication, 'New Experiments Physico-Mechanical touching the Spring and Weight of the Air,' dated 1660, the words baroscope and barometer do not occur; he uses the common term 'tube,' and often writes of the 'mercurial cylinder.' Nor are these words used by him in his 'Defense of the Doctrine touching the Spring and the Weight of the Air' * * * against the objections of Franciscus Linus, a paper published in 1662.

Their use by the anonymous writer to the *Philosophical Transactions*

in 1665 has been shown, and the question arises, who was this person who modestly concealed his name? I believe it was Boyle himself. This eminent man, who was so devoid of personal ambition that he declined a peerage, had a habit of writing about himself and his scientific labors in the third person, and often spoke of himself by fanciful, fictitious names, such as 'Philaretus' (in his fragmentary autobiography) and 'Carneades' (in the 'Sceptical Chymist'). That he should send an unsigned communication to a journal was not surprising, particularly as he had occasion to mention himself.

Be this as it may, my claim that Boyle originated the word barometer does not rest on such slender conjectures as these. One year later than the communication in the *Philosophical Transactions*, Boyle wrote to this journal (dated April 2, 1666) and said, 'barometrical observations (as for brevity's sake I call them),' using the personal pronoun this time. Elsewhere in the same paper are found the terms barometer, baroscope and baroscopical observations.

In his 'Continuation of New Experiments Physico-Mechanical' * * * of which the preface is dated 1667, occurs the following phrase: 'But though about the barometer (as others have by their imitation allowed me to call the instrument mentioned).' (Boyle's Works, Birch's edition, Vol. III, p. 219, London, 1744.)

This sentence is virtually an admission by Boyle that he had coined the word, since others imitating him had allowed and encouraged him to use the term to designate the tube of Torricelli.

I conclude, therefore, that the word 'barometer' was introduced into our language by the English philosopher, the Hon. Robert Boyle, about the year 1665. Boyle, by the way, was a scholar and able to use Greek in forming an English word. Finally, I may add that examination of Murray's 'Skeats' and other standard English dictionaries throws no light on the origin of the word; they merely refer to the *Philosophical Transactions* and give its obvious etymology.

THE WEATHER OF THE MONTH.

By Mr. W. R. STOCKMAN, Forecast Official, in charge of Division of Meteorological Records.

CHARACTERISTICS OF THE WEATHER FOR FEBRUARY.

The mean barometric pressure was high over the northwestern quarter of the United States, and low over northeastern New England.

The temperature was above the normal in mean daily values ranging from $+0.8^{\circ}$ to $+2.5^{\circ}$ in the Atlantic coast districts and the Lake region; elsewhere it was below the normal, and as a rule the mean daily departures were greater than in the districts where it was above the normal. In the middle Plateau region the mean daily departures amounted to -13.0° .

The precipitation was deficient in the upper Lake region, North Dakota, upper Mississippi Valley, the Plateau, and Pacific coast districts, the departures, however, being slight except in the northern Plateau and the middle and north Pacific districts, where they ranged from -1.3 to -3.7 inches; elsewhere the precipitation was in excess, the departures in the South Atlantic States, Florida Peninsula, Gulf States, Ohio Valley and Tennessee, and the southern slope region, ranging from $+1.4$ to $+5.7$ inches.

The relative humidity was below the normal in values of from 1 to 5 per cent in the Atlantic coast and east Gulf districts, the upper Lake region, North Dakota, the northern Plateau, and south Pacific districts; 7 per cent in the north Pacific and 8 per cent in the middle Pacific districts; elsewhere it was above normal, and markedly so in the following districts: Middle slope region, where the departure amounted to $+10$ per cent, $+11$ per cent in the northern slope region, and $+15$ per cent in the middle Plateau district.

The cloudiness was above the average in the South Atlantic and Gulf States, Florida Peninsula, upper Mississippi Valley, middle and southern slope, and southern Plateau regions. In the remaining geographical districts it was below the average, the most marked departures occurring in North Dakota and the middle and northern Plateau and Pacific districts.

The month was very stormy in New England. In North Carolina there was an unusual number of gales, that of the 16th being the heaviest of the winter.

PRESSURE.

The distribution of monthly mean pressure is shown graphically on Chart VI and the numerical values are given in Tables I and VI.

The crest of the highest barometric pressure overlay southwestern Idaho, with a mean reading of 30.31 inches at Boise. The lowest mean pressure was reported from northeastern Maine, with a reading of 29.86 inches at Eastport. Another area of relatively low pressure overlay the upper Rio Grande Valley, the mean at El Paso, Tex., being 29.95 inches.

The pressure was below the normal in New England, generally in the Middle Atlantic States and lower Lake region, and in the extreme southwestern part of California, with the greatest departures at Maine stations, the departure at Eastport amounting to -0.12 inch; elsewhere the pressure was above the normal.

Generally over the region west of the Missouri River the departures were quite decided, especially over Wyoming and northwestern Colorado, and thence northwestward over Idaho, Washington, northern and eastern Oregon, and the northern parts of Nevada and Utah. The pressure diminished from that of January, 1903, in southern Texas, New Mexico, southwestern Colorado, Arizona, and central and southern California, but in none of these districts did the departure amount to -0.10 inch except at San Diego, Cal., where it amounted to -0.12 ; elsewhere the pressure increased over that of January, with generally very decided departures in the lower Lake region, lower Ohio Valley, the southern part of the middle slope and middle Plateau regions, and thence westward and northwestward to the coasts of Oregon and Washington, the greatest increases, $+0.20$ inch to $+0.23$ inch, being reported from North Dakota, eastern Montana, and the northern part of South Dakota.

TEMPERATURE OF THE AIR.

The mean temperature was above the normal in the Atlantic States, except western Georgia, in the greater portion of the Lake region, in northwestern Minnesota, and portions of north-central and western Montana, but the departures were,

as a rule, small, the greatest being $+4.3^{\circ}$; elsewhere the temperature was below the normal, and over the middle slope, southern parts of the northern slope and Plateau, and the middle and southern Plateau regions the departures were very marked, the daily averages ranging from -11.8° to -16.7° over western Colorado, Utah, and Nevada.

The isotherms of mean temperature lay to the northward of their position in February, 1902, over the eastern part of the country, and to the southward of it over the Western States and Territories. Over Florida the isotherm of 70° occupied about the same position that 60° did in 1902. Higher maximum temperatures were reported from the eastern half of the country and lower maximum from the western part, while, as a rule, lower minimum temperatures occurred in all sections. Freezing temperatures occurred as far south as central Florida and portions of southwestern California.

Severe frosts occurred in California during the week ending the 2d, also in most sections during the week ending on the 9th; killing frosts and thick ice during the week ending the 16th, and low temperatures and severe frosts during the week ending the 22d.

The average temperatures for the several geographic districts and the departures from the normal values are shown in the following table:

Average temperatures and departures from normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since January 1.	Average departures since January 1.
		°	°	°	°
New England.....	8	28.2	+2.2	+3.1	+1.6
Middle Atlantic.....	12	36.6	+2.1	+2.4	+1.2
South Atlantic.....	10	50.8	+1.3	+0.2	+0.1
Florida Peninsula*.....	8	64.9	+2.5	+2.6	+1.3
East Gulf.....	9	51.9	+1.9	+3.2	+1.6
West Gulf.....	7	48.2	-3.4	-1.9	-1.0
Ohio Valley and Tennessee.....	11	37.1	-1.1	-1.4	-0.7
Lower Lake.....	8	27.3	+0.8	+0.8	+0.4
Upper Lake.....	10	20.5	+1.3	+3.3	+1.6
North Dakota*.....	8	3.5	-4.8	+1.3	+0.6
Upper Mississippi Valley.....	11	24.4	-1.7	+2.0	+1.0
Missouri Valley.....	11	20.6	-3.8	+1.9	+1.0
Northern Slope.....	7	17.0	-4.1	+4.8	+2.4
Middle Slope.....	6	26.9	-5.5	-0.2	-1.0
Southern Slope*.....	6	36.2	-4.3	-1.9	-0.1
Southern Plateau*.....	13	35.6	-6.1	-3.4	-1.7
Middle Plateau*.....	9	16.6	-13.0	-11.5	-5.8
Northern Plateau*.....	12	26.1	-3.0	+2.8	+1.4
North Pacific.....	7	40.3	-0.3	+2.9	+1.4
Middle Pacific.....	5	47.6	-2.7	-2.9	-1.4
South Pacific.....	4	49.8	-3.7	-1.2	-0.6

*Regular Weather Bureau and selected voluntary stations.

In Canada.—Prof. R. F. Stupart says:

The temperature was just about the average over British Columbia and in the extreme eastern portions of the Province of Quebec and the Maritime Provinces, and elsewhere in the Dominion it was above the average. The plus departure was especially marked in Alberta, both Edmonton and Calgary recording an excess of 9° . It was also well marked in Manitoba, with an excess of from 3° to 4° , and over a large portion of Ontario, with an excess of from 3° to 5° .

PRECIPITATION.

The precipitation was below normal west of the upper Lake region, in the Pacific districts, and generally in the middle and southern Plateau regions, and above normal generally in all other sections. In the middle and north Pacific districts the deficiencies were quite marked, as were the excesses in the Gulf States generally, and in portions of the Ohio Valley and Tennessee, the western part of the South Atlantic States, and the south-central part of the southern slope region, the most marked departures occurred in the east Gulf States and portions of the west Gulf States, in which districts monthly amounts ranging from 10.0 inches to 15.0 inches were reported.

In many sections the snowfall was heavy, and occurred every-

where, except in portions of the South Atlantic States, and along the coast of the Gulf of Mexico.

At the end of the month there was snow on the ground in portions of New York, Pennsylvania, New England, and in the upper Lake region, and thence southwestward to central New Mexico and westward to about the one hundred and twentieth meridian.

HAIL.

The following are the dates on which hail fell in the respective States:

Alabama, 5. Arizona, 6, 14, 15, 24. Arkansas, 2, 3, 6, 7, 15, 16. California, 1, 2, 3, 4, 5, 7, 11, 13, 14, 22. Connecticut, 8, 15. Delaware, 1, 14, 16. Florida, 21. Indiana, 28. Indian Territory, 2, 13. Iowa, 3. Kansas, 3, 14. Kentucky, 16. Maine, 4, 11. Maryland, 1, 4, 14, 16, 17. Massachusetts, 8, 16. Michigan, 2, 3, 4, 12, 28. Minnesota, 3, 27. Mississippi, 3, 14, 26, 27. Missouri, 2, 3. New Hampshire, 2, 3, 4, 8. New Jersey, 4, 8, 11, 12, 14, 15, 16. New York, 8, 28. North Carolina, 6, 17, 28. Ohio, 2, 3, 28. Oklahoma, 2, 3, 15. Oregon, 7, 9, 10. Pennsylvania, 8, 14, 15, 16, 28. Rhode Island, 8. Tennessee, 4, 16. Texas, 2, 6, 10, 12, 15, 16, 19, 25, 26, 27. Virginia, 7, 17. Washington, 20. West Virginia, 1, 11, 28. Wisconsin, 2. Wyoming, 10.

SLEET.

The following are the dates on which sleet fell in the respective States:

Alabama, 6, 16. Arizona, 2, 26. Arkansas, 5, 6, 13, 14, 15, 16, 19, 20. California, 1, 2, 3, 7, 8, 11, 13. Connecticut, 8, 14, 15. District of Columbia, 1, 16, 17. Georgia, 6, 16. Idaho, 10. Illinois, 1, 2, 3, 9, 10, 11, 14, 15, 20, 24, 25, 26, 27, 28. Indiana, 2, 3, 14, 15, 16, 23, 24, 28. Indian Territory, 6, 10, 13, 15. Iowa, 2, 3, 19, 26, 27, 28. Kansas, 2, 3, 6, 7, 13, 14, 15, 26, 27. Kentucky, 7, 8, 15, 16, 24. Louisiana, 5, 6, 15, 16, 19. Maine, 2, 4, 5. Maryland, 1, 8, 14, 15, 16, 17. Massachusetts, 4, 8, 11, 16, 28. Michigan, 2, 3, 4, 27. Minnesota, 27, 28. Mississippi, 5, 7, 15, 16, 17, 19, 20. Missouri, 2, 3, 7, 13, 14, 15, 16. Montana, 9, 22. Nebraska, 3, 11, 26, 27. New Hampshire, 4, 5, 8. New Jersey, 4, 8, 11, 14, 15, 16, 17. New Mexico, 2, 15, 19. New York, 2, 3, 4, 6, 8, 12, 15, 16. North Carolina, 6, 16. Ohio, 2, 3, 7, 8, 13, 14, 15, 16, 18, 28. Oklahoma, 7, 13, 14, 15. Oregon, 7. Pennsylvania, 1, 8, 11, 14, 15, 16, 17. Rhode Island, 8, 16. South Carolina, 5, 6, 7. South Dakota, 27. Tennessee, 6, 7, 10, 15, 16, 17. Texas, 5, 6, 7, 13, 14, 15, 16, 18, 19, 25, 28. Utah, 27. Vermont, 4, 8, 11. Virginia, 1, 7, 8, 16, 17. Washington, 7, 8, 9, 10, 13. West Virginia, 1, 8, 15, 16, 17. Wisconsin, 2, 13.

Average precipitation and departure from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
		Inches.		Inches.	Inches.
New England.....	8	3.97	111	+0.4	+0.1
Middle Atlantic.....	12	4.16	124	+0.8	+0.6
South Atlantic.....	10	5.09	141	+1.4	+1.0
Florida Peninsula*.....	8	5.15	169	+2.1	+4.8
East Gulf.....	9	10.50	219	+5.7	+4.7
West Gulf.....	7	6.30	185	+2.9	+2.0
Ohio Valley and Tennessee.....	11	6.04	142	+1.8	-0.1
Lower Lake.....	8	3.28	122	+0.6	+0.2
Upper Lake.....	10	1.76	95	-0.1	-0.9
North Dakota*.....	8	0.27	40	-0.4	-0.2
Upper Mississippi Valley.....	11	1.87	95	-0.1	-0.1
Missouri Valley.....	11	1.47	116	+0.2	-0.3
Northern Slope.....	7	0.74	137	+0.2	-0.1
Middle Slope.....	6	1.61	199	+0.8	+0.2
Southern Slope*.....	6	3.26	340	+2.3	+1.8
Southern Plateau*.....	13	0.87	90	-0.1	-0.9
Middle Plateau*.....	8	0.92	75	-0.3	-0.2
Northern Plateau*.....	12	0.31	19	-1.3	-1.7
North Pacific.....	7	1.98	35	-3.7	-4.2
Middle Pacific.....	5	2.04	49	-2.1	-1.8
South Pacific.....	4	1.90	73	-0.7	-1.3

*Regular Weather Bureau and selected voluntary stations.

In Canada.—Professor Stupart says:

In Ontario the precipitation was above the average east to the boundary of the Province from an imaginary line drawn north and south from the Georgian Bay district, the excess increasing gradually until 1.50 inches was reached on the eastern margin. Throughout Quebec the average was exceeded by from 2.25 inches to over 3.00 inches. In the Maritime Provinces there was an excess of about an inch in the northern parts and a deficiency in the extreme south and southwest portions of from 1.00 inch to nearly 2.00 inches; elsewhere in Canada the average was not maintained, but the minus departure was not marked, except in portions of British Columbia where it was very much so, Barkerville and Victoria recording 2.50 inches below the average, and New Westminster close on to 6.00 inches below.

HUMIDITY.

The averages by districts appear in the subjoined table:

Average relative humidity and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	73	- 2	Missouri Valley	81	+ 4
Middle Atlantic	72	- 2	Northern Slope	80	+11
South Atlantic	74	- 4	Middle Slope	76	+10
Florida Peninsula	80	- 2	Southern Slope	78	+ 8
East Gulf	77	- 1	Southern Plateau	53	+ 5
West Gulf	79	+ 6	Middle Plateau	77	+15
Ohio Valley and Tennessee	77	+ 3	Northern Plateau	75	- 3
Lower Lake	81	+ 1	North Pacific	78	- 7
Upper Lake	80	- 1	Middle Pacific	68	- 8
North Dakota	76	- 5	South Pacific	68	- 3
Upper Mississippi Valley	80	+ 3			

SUNSHINE AND CLOUDINESS.

The distribution of sunshine is graphically shown on Chart VII, and the numerical values of average daylight cloudiness, both for individual stations and by geographical districts, appear in Table I.

The averages for the various districts, with departures from the normal, are shown in the table below:

Average cloudiness and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	5.4	- 0.1	Missouri Valley	4.9	- 0.5
Middle Atlantic	5.3	- 0.3	Northern Slope	4.4	- 0.4
South Atlantic	5.7	+ 0.4	Middle Slope	4.8	+ 0.4
Florida Peninsula	5.6	+ 1.0	Southern Slope	6.4	+ 1.6
East Gulf	6.9	+ 1.4	Southern Plateau	3.3	+ 0.3
West Gulf	6.5	+ 0.7	Middle Plateau	3.4	- 1.4
Ohio Valley and Tennessee	6.0	- 0.2	Northern Plateau	4.8	- 1.9
Lower Lake	6.4	- 0.4	North Pacific	5.5	- 1.5
Upper Lake	5.8	- 0.5	Middle Pacific	3.8	- 1.0
North Dakota	3.0	- 2.1	South Pacific	3.0	- 1.1
Upper Mississippi Valley	5.4	+ 0.1			

WIND.

The maximum wind velocity at each Weather Bureau station

for a period of five minutes is given in Table I, which also gives the altitude of Weather Bureau anemometers above ground.

Following are the velocities of 50 miles and over per hour registered during the month:

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Amarillo, Tex	3	50	w.	Havre, Mont	9	60	sw.
Atlanta, Ga.	16	60	nw.	Huron, S. D.	28	52	nw.
Block Island, R. I.	5	56	nw.	Jacksonville, Fla.	16	75	sw.
Do.	6	50	nw.	Knoxville, Tenn.	4	60	sw.
Do.	9	56	nw.	Lexington, Ky.	4	50	w.
Do.	17	60	ne.	Lincoln, Nebr.	28	52	nw.
Do.	18	50	w.	Milwaukee, Wis.	4	56	ne.
Do.	28	56	s.	Minneapolis, Minn.	28	50	n.
Buffalo, N. Y.	2	51	w.	Mount Tamalpais, Cal.	11	56	nw.
Do.	4	59	sw.	Do.	13	56	ne.
Do.	5	50	sw.	Do.	14	50	ne.
Do.	8	72	sw.	New York, N. Y.	4	63	w.
Do.	17	50	sw.	Do.	5	72	nw.
Do.	18	54	w.	Do.	9	59	nw.
Do.	19	50	w.	Do.	17	55	nw.
Do.	28	60	w.	Do.	18	52	w.
Cairo, Ill.	4	53	sw.	Do.	28	50	s.
Chicago, Ill.	3	50	ne.	North Head, Wash.	7	71	se.
Do.	22	50	s.	Do.	8	72	s.
Cleveland, Ohio	4	56	w.	Do.	9	80	s.
Do.	5	57	w.	Point Reyes Light, Cal.	1	60	nw.
Do.	18	50	w.	Do.	7	74	s.
Columbia, S. C.	16	60	sw.	Do.	11	65	nw.
Do.	17	56	sw.	Do.	12	60	nw.
Columbus, Ohio	4	61	sw.	St. Louis, Mo.	4	51	sw.
Do.	28	56	w.	Sioux City, Iowa.	27	50	nw.
Duluth, Minn.	18	56	nw.	Do.	28	52	nw.
Do.	28	52	nw.	Syracuse, N. Y.	11	50	s.
Eastport, Me.	8	51	e.	Do.	28	59	sw.
Do.	17	52	ne.	Tatoosh Island, Wash.	7	54	s.
Do.	28	50	sw.	Do.	8	52	nw.
Green Bay, Wis.	4	55	n.	Do.	9	72	sw.
Harrisburg, Pa.	5	50	nw.	Do.	10	60	nw.
Hatteras, N. C.	16	59	sw.	Williston, N. Dak.	27	50	n.

ATMOSPHERIC ELECTRICITY.

Numerical statistics relative to auroras and thunderstorms are given in Table IV, which shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month, respectively.

Thunderstorms.—Reports of 802 thunderstorms were received during the current month as against 975 in 1902 and 372 during the preceding month.

The dates on which the number of reports of thunderstorms for the whole country was most numerous were: 3d, 129; 2d, 110; 4th, 100.

Reports were most numerous from: Texas, 96; Louisiana, 74; Mississippi, 70.

Auroras.—The evenings on which bright moonlight must have interfered with observations of faint auroras are assumed to be the four preceding and following the date of full moon, viz: 7th to 15th.

In Canada: Thunderstorms were reported at Chatham, 5th; Ottawa, 4th; Parry Sound, 2d. Auroras were reported at Qu'Appelle, 21st; Swift Current, 23d.

DESCRIPTION OF TABLES AND CHARTS.

By Mr. W. B. STOCKMAN, Forecast Official, in charge of Division of Meteorological Records.

For description of tables and charts see page 582 of REVIEW for December, 1902.

TABLE 1.—Climatological data for Weather Bureau Stations, February, 1903.

Stations.	Elevation of instruments.			Pressure, in inches.		Temperature of the air, in degrees Fahrenheit.										Precipitation, in inches.			Wind.						
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max., mean min., +2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Total.	Departure from normal.	Days with .01 or more.	Total movement, miles.	Prevailing direction.	Maximum velocity.	
<i>New England.</i>																									
Eastport.....	76	69	74	29.77	29.86	-.12	32.2	2.2	52	28	29	-7	20	15	21	20	17	73	3.97	+0.4	16	10,888	nw.	52	
Portland, Me.....	103	81	117	29.82	29.95	-.07	26.4	+1.8	53	28	34	-5	20	19	29	23	16	67	3.44	+0.3	11	7,227	w.	38	
Concord.....	298	70	79	29.64	29.98	-.06	25.6	+2.2	58	28	35	-18	20	16	45	...	...	...	3.75	+0.5	11	4,590	w.	37
Northfield.....	876	16	60	28.99	29.98	-.06	19.2	+3.2	59	28	30	-17	18	9	38	17	12	72	3.53	+1.2	11	6,057	s.	46	
Boston.....	125	115	181	29.84	29.90	-.05	31.4	+3.4	62	28	38	3	18	24	25	28	21	68	3.90	+0.4	11	9,177	w.	46	
Nantucket.....	12	43	85	29.98	29.99	-.05	32.7	+1.7	52	28	38	8	19	27	28	30	26	79	3.32	+0.4	11	11,294	nw.	48	
Block Island.....	31	11	60	30.00	30.03	-.03	31.3	+2.2	55	28	39	7	19	27	24	30	24	72	4.61	+0.2	10	14,673	nw.	60	
Narragansett.....	...	...	...	...	...	...	31.3	+2.2	56	28	40	-2	18	22	35	...	...	...	5.19	+0.7	10	...	nw.	...
New Haven.....	106	117	140	29.91	30.03	-.04	31.7	+2.9	57	28	39	1	19	24	31	28	23	73	3.98	+0.1	11	6,710	w.	42	
<i>Mid. Atlantic States.</i>																									
Albany.....	97	102	115	29.93	30.04	-.03	27.0	+2.8	63	28	35	-4	19	20	19	28	25	22	85	2.05	+0.6	8	5,717	s.	39
Binghamton.....	875	79	90	29.07	30.04	-.04	27.4	+3.5	61	28	33	-4	19	20	34	...	...	...	2.24	+0.6	14	5,787	w.	36
New York.....	314	108	350	29.70	30.05	-.03	34.4	+2.9	62	28	40	2	19	28	29	30	24	68	3.83	+0.0	9	12,118	w.	72	
Harrisburg.....	374	94	104	29.68	30.09	-.00	32.8	+0.3	62	28	40	1	19	26	26	28	23	70	4.19	+1.4	9	6,121	w.	50	
Philadelphia.....	117	168	184	29.96	30.09	-.01	36.5	+3.0	67	28	44	3	19	29	23	32	27	71	4.29	+1.1	10	6,861	nw.	39	
Seranton.....	805	111	119	29.17	30.07	-.01	30.0	...	64	28	38	-3	19	22	34	26	20	69	3.54	...	11	5,424	sw.	41	
Atlantic City.....	52	39	48	30.03	30.12	-.01	36.4	+2.5	65	13	43	4	19	30	25	32	29	77	5.22	+1.9	10	6,691	nw.	34	
Cape May.....	17	47	51	30.10	30.12	-.01	37.4	+1.7	62	13	43	8	19	32	23	34	...	...	5.65	+1.9	11	6,755	nw.	36
Baltimore.....	123	69	117	29.95	30.09	-.02	37.8	+1.6	71	28	45	5	19	30	28	32	25	65	5.43	+1.9	10	6,073	w.	45	
Washington.....	112	59	76	29.98	30.11	-.06	37.4	+1.6	73	28	46	3	18	29	32	33	27	71	5.32	+2.0	10	5,485	nw.	44	
Cape Henry.....	18	58	58	30.10	30.11	-.00	44.3	+0.4	76	28	52	17	19	37	30	...	...	...	2.46	+1.1	8	9,964	s.	73
Lynchburg.....	681	83	88	29.34	30.10	-.01	41.2	+1.2	71	28	51	8	19	31	36	36	30	70	5.99	+2.5	11	5,569	sw.	27	
Norfolk.....	91	102	111	30.03	30.13	-.02	46.0	+3.2	74	28	55	14	19	37	32	40	35	72	3.24	+0.6	8	7,235	s.	40	
Richmond.....	144	82	90	29.97	30.13	-.02	43.0	...	72	28	52	11	19	34	33	...	...	...	5.02	...	8	4,473	sw.	33
Wytheville.....	2,290	40	47	27.67	30.12	-.09	37.8	...	66	28	49	2	19	27	37	33	29	78	5.33	...	10	5,144	w.	36	
<i>Atlantic States.</i>																									
Asheville.....	2,255	73	100	27.74	30.11	-.02	41.3	...	69	15	53	5	18	30	38	35	30	70	7.02	...	11	6,724	n.	40	
Charlotte.....	773	68	76	29.28	30.13	-.01	46.3	+1.3	69	28	55	17	18	37	28	40	34	69	6.02	+1.5	10	5,647	sw.	48	
Hatteras.....	11	12	47	30.14	30.15	-.04	49.8	+3.2	71	15	56	25	19	44	21	47	44	83	4.82	+0.4	9	11,564	sw.	59	
Kittyhawk.....	...	...	...	...	...	...	43.2	...	72	28	53	18	19	37	32	...	...	...	3.74	...	0	10,257	ne.	...
Raleigh.....	376	93	101	29.72	30.13	-.02	46.2	+2.3	71	28	56	17	18	36	33	41	35	70	6.67	+2.9	9	4,988	nw.	36	
Wilmington.....	78	82	90	30.05	30.13	-.01	51.7	+1.9	76	14	61	23	18	42	33	45	40	74	3.54	+0.3	9	6,780	sw.	51	
Charleston.....	48	14	92	30.11	30.17	-.05	53.8	+1.0	73	2	61	24	18	47	35	48	45	79	2.07	+1.2	11	8,360	sw.	46	
Columbia.....	351	114	122	29.77	30.16	-.05	50.0	+1.9	74	15	59	19	18	41	28	44	39	71	7.30	+3.1	11	6,904	sw.	69	
Augusta.....	180	89	97	29.95	30.15	-.03	50.5	+1.1	76	15	60	20	18	41	38	45	40	78	7.46	+3.5	9	4,894	sw.	46	
Savannah.....	65	79	89	30.08	30.15	-.03	55.4	+1.1	80	16	64	26	18	47	28	49	46	78	4.08	+1.0	12	6,331	nw.	48	
Jacksonville.....	43	101	129	30.08	30.13	-.01	59.2	+0.8	81	14	68	29	18	51	27	53	50	78	5.23	+2.1	14	7,956	s.	75	
<i>Florida Peninsula.</i>																									
Jupiter.....	28	10	48	30.08	30.11	-.03	70.6	+3.5	84	8	76	40	18	63	20	66	63	80	4.50	+1.8	9	10,278	se.	42	
Key West.....	22	45	50	30.06	30.07	-.00	73.8	+2.4	84	12	78	54	18	70	21	69	67	83	1.97	+0.3	7	7,633	se.	36	
Tampa.....	34	60	67	30.08	30.12	-.02	64.8	+2.0	84	14	73	32	18	56	27	58	55	78	6.06	+3.0	13	5,722	ne.	41	
<i>East Gulf States.</i>																									
Atlanta.....	1,174	190	216	28.88	30.14	-.02	46.4	+1.6	69	27	55	12	17	38	43	41	37	74	9.66	+5.0	12	9,954	nw.	60	
Macon.....	370	93	99	29.75	30.15	-.03	50.4	...	77	27	60	21	17	41	38	...	...	...	6.25	...	11	5,120	nw.	45
Pensacola.....	56	79	96	30.07	30.12	-.01	55.6	+1.2	70	2	62	27	17	49	34	...	...	...	8.51	+4.4	15	8,172	e.	45
Mobile.....	57	88	96	30.06	30.12	-.01	54.4	+0.4	72	7	62	24	17	47	39	49	44	75	8.83	+4.1	12	5,784	n.	27	
Montgomery.....	223	100	112	29.89	30.14	-.02	51.2	+1.5	80	14	60	19	17	42	46	47	43	79	11.76	+6.4	12	5,549	se.	42	
Meridian.....	375	84	93	29.72	30.14	-.03	49.1	+4.5	78	14	59	15	17	40	38	...	...	...	13.30	+7.7	14	4,813	ne.	34
Vicksburg.....	247	62	74	29.81	30.08	-.02	50.1	+2.5	76	15	58	18	17	42	41	46	42	79	11.45	+6.8	14	5,731	nw.	36	
New Orleans.....	51	88	121	30.05	30.10	-.01	56.4	+1.7	80	14	64	27	17	49	39	52	47	77	10.20	+5.7	13	7,005	ne.	42	
<i>West Gulf States.</i>																									
Shreveport.....	249	77	84	29.84	30.12	-.03	48.5	+2.7	73	2	56	15	17	41	27	44	39	77	5.79	+1.6	14	5,057	ne.	33	
Fort Smith.....	457	79	94	29.62	30.12	-.02	39.9	+1.6	74	2	48	4	17	32	31	36	31	75	5.33	+1.7	9	7,055	e.	48	
Little Rock.....	357	93	100	29.75	30.14	-.03	42.6	+2.8	73	2	50	7	17	35	29	38	33	73	6.50	+1.2	10	6,169	ne.	38	
Corpus Christi.....	20	48	53	30.04	30.06	-.01	55.6	+3.4	78	3	62	27	17	50	25	52	50	84	5.81	+3.4	13	7,531	n.	38	
Fort Worth.....	670	106	114	29.37	30.10	-.03	43.4	...	78	2	51	12	16	36	30	...	...	...	4.63	...	13	7,441	n.	40
Galveston.....	54	106	112	30.00	30.05	-.02	53.6	+3.4	67	2	59	24	17	48	23	51	49	86	6.84	+3.8	13	8,904	se.	48	
Palestine.....	519	73	79	29.56	30.11	-.03	47.0	+4.0	78	2	54	14	1												

TABLE I.—Climatological data for Weather Bureau Stations, February, 1903—Continued.

Stations.	Elevation of instruments.			Pressure, in inches.		Temperature of the air, in degrees Fahrenheit.										Precipitation, in inches.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.		
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean maximum.	Mean minimum.	Mean range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.					
North Dakota.																														
Moorhead.	935	54	60	29.12	30.20	+.09	3.5	3.8	14.8	1.4	42	26	24	16	6	32	76	0.35	-.02	6	6,373	nw.	36	nw.	27	21	2	5	3.0	
Bismarck.	1,674	16	29	28.35	30.26	+.14	2.6	3.8	14.8	1.4	42	26	24	16	6	32	76	0.35	-.02	6	6,373	nw.	36	nw.	27	21	2	5	3.0	
Williston.	1,885	14	44	28.09	30.21	+.10	2.4	3.8	14.8	1.4	42	26	24	16	6	32	76	0.35	-.02	6	6,373	nw.	36	nw.	27	21	2	5	3.0	
Upper Miss. Valley.																														
Minneapolis.	99	308	122	29.19	30.14	+.05	14.3	1.5	42	26	23	18	16	6	32	84	0.62	-.03	7	5,410	nw.	36	nw.	28	16	9	3	2.6		
St. Paul.	837	102	122	29.19	30.14	+.05	14.3	1.5	42	26	23	18	16	6	32	84	0.62	-.03	7	5,410	nw.	36	nw.	28	16	9	3	2.6		
La Crosse.	714	71	87	29.32	30.13	+.05	17.6	1.5	42	26	23	18	16	6	32	84	0.62	-.03	7	5,410	nw.	36	nw.	28	16	9	3	2.6		
Davenport.	696	71	79	29.44	30.12	+.02	23.6	1.7	50	27	32	13	17	16	27	22	19	82	1.67	+.01	6	5,688	w.	32	ne.	3	11	7	10	5.2
Des Moines.	861	84	88	29.22	30.18	+.07	22.0	1.1	46	22	31	13	18	13	34	19	16	80	1.12	+.02	6	6,524	sw.	32	ne.	28	6	14	8	5.5
Dubuque.	698	100	117	29.34	30.14	+.05	22.4	1.2	49	26	31	14	18	14	38	19	15	77	1.19	+.03	8	5,358	nw.	32	nw.	18	9	6	13	6.1
Keokuk.	614	63	78	29.45	30.14	+.03	26.4	1.9	51	27	34	13	17	19	28	23	19	78	1.42	+.03	9	5,993	sw.	34	w.	28	10	7	11	5.1
Cairo.	356	87	93	29.75	30.15	+.03	37.5	1.9	66	1	45	1	17	30	30	34	31	80	4.19	+.02	13	7,762	nw.	53	sw.	4	9	6	13	5.9
Springfield, Ill.	644	82	93	29.42	30.14	+.04	28.2	2.1	56	27	36	12	17	20	26	25	22	83	3.05	+.03	10	7,299	nw.	34	nw.	18	9	6	13	5.9
Hannibal.	534	75	110	29.52	30.12	+.01	27.6	2.9	58	1	36	18	17	19	36	24	22	79	2.70	+.08	10	7,120	w.	36	nw.	18	6	9	13	6.6
St. Louis.	367	111	210	29.51	30.14	+.03	33.6	1.5	62	1	41	6	17	26	24	30	26	78	3.14	+.04	13	7,754	s.	31	sw.	4	8	7	13	6.1
Missouri Valley.																														
Columbia.	784	11	84	29.27	30.14	+.03	28.8	1.4	63	1	38	15	17	20	38	24	22	81	1.47	+.02	9	6,817	sw.	39	nw.	18	9	4	15	6.3
Kansas City.	963	78	95	29.11	30.18	+.07	28.5	2.5	64	1	36	9	17	21	33	25	21	78	1.89	+.01	8	6,217	nw.	34	nw.	18	13	7	8	4.7
Springfield, Mo.	1,324	98	104	28.68	30.12	+.01	31.9	2.8	67	1	40	3	17	24	31	29	26	83	3.35	+.03	10	8,173	se.	46	w.	4	11	8	9	5.2
Topeka.	81	89	104	28.85	30.18	+.08	27.8	3.5	66	1	37	10	17	18	42	38	18	78	1.14	+.05	7	7,042	n.	34	n.	28	10	9	9	5.2
Lincoln.	1,189	75	84	28.85	30.18	+.08	21.2	2.2	49	22	30	13	18	12	38	18	14	78	1.39	+.05	7	7,893	n.	52	nw.	28	12	8	8	4.6
Omaha.	1,105	115	121	28.95	30.19	+.08	21.1	3.9	47	22	29	15	18	13	34	18	15	82	1.12	+.03	7	7,191	n.	41	n.	28	8	9	11	5.9
Valentine.	2,598	47	54	27.32	30.18	+.09	16.0	5.5	47	22	26	18	18	6	40	14	12	86	0.73	0.0	6	6,538	nw.	49	nw.	28	11	6	11	5.0
Sioux City.	1,135	96	164	28.91	30.19	+.07	16.2	2.8	45	22	25	18	18	7	31	1	7	78	0.66	+.01	5	8,426	e.	52	nw.	28	11	9	8	4.8
Pierre.	1,572	43	50	28.48	30.24	+.13	13.7	1.7	46	22	23	20	16	4	29	11	7	78	0.36	0.0	4	4,374	e.	46	n.	28	12	10	6	4.8
Huron.	1,306	56	67	28.75	30.24	+.12	7.5	4.5	39	10	18	29	17	3	35	6	2	79	0.31	0.3	2	7,475	nw.	52	nw.	28	17	9	2	8.5
Yankton.	1,233	42	49	28.80	30.20	+.08	13.4	5.8	47	22	24	22	16	3	37	1	2	79	2.58	+.18	6	5,299	w.	42	nw.	28	13	11	4	4.1
Northern Slope.																														
Havre.	2,505	46	53	27.43	30.21	+.14	14.2	1.0	48	26	26	27	15	3	43	13	11	87	0.21	0.3	5	6,080	sw.	60	sw.	9	14	7	7	4.3
Miles City.	2,371	42	50	27.57	30.22	+.13	11.2	5.0	42	10	23	30	16	1	40	8	7	89	0.51	0.0	3	2,911	sw.	28	w.	11	15	10	3	3.6
Helena.	4,110	88	94	25.84	30.20	+.09	23.0	1.3	51	21	31	7	13	14	26	20	14	89	0.09	0.7	2	4,132	sw.	33	sw.	17	12	9	7	4.3
Kalispell.	2,965	45	51	27.02	30.21	+.13	20.6	4.6	23	30	1	4	12	11	28	18	15	80	0.48	0.0	8	3,490	w.	30	sw.	10	15	10	3	3.6
Rapid City.	3,234	46	50	26.64	30.20	+.12	18.6	2.0	53	22	30	16	18	8	41	16	12	80	0.47	0.2	7	4,640	nw.	38	nw.	27	15	8	5	3.9
Cheyenne.	6,088	56	64	23.91	30.18	+.15	15.8	11.5	45	22	25	20	15	6	30	13	8	76	1.76	+.14	13	7,459	nw.	45	nw.	10	12	5	11	5.3
Lander.	5,372	26	36	24.61	30.22	+.14	16.0	7.0	48	22	30	28	14	2	51	12	9	79	0.82	0.1	7	2,078	se.	32	w.	10	13	9	6	4.1
North Platte.	2,821	43	52	27.15	30.22	+.15	20.0	5.3	48	22	29	11	17	11	50	17	14	84	1.29	+.09	10	5,412	w.	38	nw.	28	9	8	11	5.8
Middle Slope.																														
Denver.	5,291	79	151	24.67	30.15	+.14	22.7	9.5	55	22	33	10	15	12	37	18	13	71	1.61	+.08	8	5,352	s.	38	nw.	10	14	6	8	4.2
Pueblo.	4,685	80	86	25.26	30.12	+.12	24.2	5.9	58	10	36	13	16	12	47	20	13	66	1.20	0.8	11	4,698	n.	43	w.	11	8	14	6	5.1
Concordia.	1,398	42	47	28.65	30.18	+.09	24.2	4.0	55	1	32	12	16	16	51	20	17	80	0.80	0.0	8	4,740	n.	32	nw.	28	12	6	10	5.1
Dodge.	2,509	44	54	27.46	30.18	+.12	26.2	5.6	65	1	37	18	16	15	43	22	19	84	2.87	+.22	10	7,056	ne.	42	sw.	1	14	1	13	5.0
Wichita.	1,358	78	86	28.68	30.17	+.09	29.6	2.2	69	1	39	6	16	20	34	26	21	77	1.71	+.05	7	6,842	ne.	32	n.	28	15	4	9	4.6
Oklahoma.	1,214	79	86	28.80	30.12	+.05	34.6	5.9	69	1	43	4	16	26	29	30	26	77	2.65	+.17	8	8,224	n.	40	n.	15	12	6	10	5.1
Southern Slope.																														
Abilene.	1,738	45	54	28.25	30.10	+.05	40.3	5.6	76	1	49	11	17	32	38	36	33	80	4.07	+.27	10	6,138	nw.	48	w.	3	4	6	18	7.4
Amarillo.	3,676	43	52	26.23	30.08	+.06	29.2	6.4	66	11	40	3	16	18	42	24	20	76	2.93	+.21	9	8,173	sw.	50	w.	3	13	6	9	5.4
Southern Plateau.																														
El Paso.	3,762	10	110	26.13	29.95	+.00	43.6	5.8	73	12	56	14	17	31	41	35	24	55	1.09	+.07	7	7,689	ne.	45	sw.	12	11	10	7	4.4
S																														

TABLE II.—Climatological record of voluntary and other cooperating observers, February, 1903.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Alabama.				<i>Ins.</i>	<i>Ins.</i>
Anniston.....	70	11	48.0	8.88	0.3
Ashville.....	70	11	45.8	13.24	
Benton.....	83	21	52.8	10.81	
Bermuda.....	73	13	49.4	15.86	
Birmingham.....				11.33	
Bridgeport.....				11.75	
Burkeville.....				10.94	
Calera.....	74	16	49.1	11.42	T.
Campbell.....	78	20	54.8	9.33	
Citronelle.....				12.01	T.
Cordova.....	75	24	55.3	12.19	
Daphne.....	74	9	48.6	11.03	T.
Decatur.....				9.59	
Demopolis.....	77	24	54.8	5.53	T.
Dothan.....	77	23	50.9	6.71	
Eufaula.....	80	14	47.8	10.53	T.
Eutaw.....	78	23	52.8	11.18	
Evergreen.....	82	23	54.2	10.36	T.
Flomaton.....				9.66	1.0
Florence a.....	71	3	45.4	8.01	1.4
Florence b.....	78	18	48.6	10.33	T.
Fort Deposit.....	70	10	45.5	11.18	
Gadsden.....	74	13	46.5	16.66	T.
Goodwater.....	77	16	51.4	9.27	T.
Greensboro.....	78	4	45.9	9.02	3.5
Hamilton.....				16.16	T.
Helena.....	80	18	51.6	9.57	
Highland Home.....				8.92	
Letohatchie.....	82	16	50.0	15.47	
Livingston a.....	72	16	46.0	14.20	
Lock No. 4.....	71	4	46.6	11.68	1.0
Madison Station.....	72	10	43.8	13.63	
Maple Grove.....	76	14	48.3	9.69	T.
Marion.....				10.82	
Milstead.....	82	14	50.3	8.41	T.
Newbern.....	78	0	43.9	8.42	4.0
Notasulga.....				12.86	T.
Oneonta.....	69	7	45.1	14.42	0.5
Ozark.....	79	22	52.0	3.23	
Prattville.....	79	15	49.8	12.31	T.
Pushmataha.....	80	17	50.2	13.22	
Riverton.....	72	3	43.0	8.94	11.0
Scottsboro.....	68	8	42.0	12.44	0.3
Selma.....	73	16	49.2	12.54	
Talladega.....	75	19	48.8	11.46	0.2
Tallassee.....				12.27	T.
Thomasville.....	80	17	48.7	6.50	
Tusculloosa.....	75	12	46.6	14.94	0.2
Tuscumbia.....	71	4	42.4	10.43	
Tuskegee.....	78	18	52.0	9.42	
Union Springs.....	76	20	51.2	12.33	T.
Uniontown.....	80	15	49.8	8.91	0.1
Valleyhead.....	68	7	45.4	11.42	0.5
Verbena.....				15.16	
Wetumpka.....	77	19	51.0	11.50	
Alaska.					
Copper Center.....	43	-55	8.0	0.05	0.5
Killsnoo.....	40	8	30.8	2.40	7.0
Sitka.....	44	10	34.0	8.68	16.0
Skagway.....	44	-1	27.1	1.44	4.5
Arizona.					
Agua Caliente.....	82	21	50.5	0.04	
Allaire Ranch.....				0.54	4.8
Arizona Canal Co's Dam.....	76	29	51.6	1.41	
Astec.....	84	30	54.0	T.	
Blabec.....	66	15	43.2	1.17	11.9
Bowie.....	68	19	44.0	0.61	6.1
Buckeye.....	80	21	48.3	0.00	0.0
Casa Grande.....				0.66	
Cochise *.....	75	27	44.1	4.20	
Congress.....	68	26	46.0	0.40	0.5
Dragoon Summit.....				1.15	11.5
Dudleyville.....	79	21	46.2	0.92	T.
Duncan.....	75	11	40.4	0.10	1.0
Fort Apache.....	64	4	34.1	1.30	13.0
Fort Defiance.....	45	-18	19.8	2.47	24.7
Fort Grant.....	66	25	46.1	0.09	0.9
Fort Huachuca.....	69	19	44.5	0.95	9.5
Globe.....	68	21	41.2	0.40	3.5
Jerome.....	61	13	38.2	0.46	4.6
Maricopa.....	77	24	46.8	0.47	
Mesa.....	78	24	48.6	0.92	T.
Mesa (near).....	77	23	46.7	0.82	
Mount Huachuca.....	69	18	43.4	0.69	
Mohawk Summit *.....	80	34	53.3		
Natural Bridge.....				2.64	27.0
Nogales.....	71	19	45.1	0.50	2.2
Oracle.....	61	16	41.8	2.75	13.0
Oro.....				0.48	
Phoenix.....	72	24	47.7	0.50	T.
Pima.....	72	16	44.0	0.46	
Prescott.....	60	-6	30.8	1.40	14.0
San Simon.....	72	18	44.6	1.05	7.0
Sentinel *.....	78	30	52.3		
Showlow.....				2.96	29.0
Signal.....	80	16	45.4	0.49	
Superstition.....				2.25	6.0
Arizona—Cont'd.					
Taylor.....	57	-11	26.8	2.04	24.0
Tonto.....	70	20	45.9	1.40	4.0
Tuba.....	55	8	30.2	0.20	2.0
Tucson.....	76	24	45.3	1.11	4.9
Vail *.....	76	27	50.6	2.15	21.5
Walnut Grove.....				0.40	4.0
Willcox *.....	68	16	40.0	0.73	7.3
Yarnell.....				0.77	5.0
Arkansas.					
Aleo.....	73	-4	39.0	7.40	2.2
Amity.....	74	3	43.2	9.30	1.0
Arkadelphia.....	74	3	44.4	9.39	2.0
Arkansas City.....				8.96	
Batesville.....	72	-3	40.8	6.92	
Beebranch.....	74	7	43.9	6.85	3.5
Blanchard.....	70	5	46.2	9.35	2.0
Brinkley.....	74	3	42.5	5.31	4.0
Camden a.....				6.95	4.0
Camden b.....	73	10	44.6	7.62	2.0
Conway.....	75	-2	40.8	8.64	2.5
Corning.....	73	3	37.5	8.20	4.6
Dallas.....	72	-3	43.6	7.52	3.0
Dardanelle.....				6.30	0.4
Dodd City.....	70			5.30	2.5
Dutton.....	68	-7	36.4	6.40	4.0
Eureka Springs.....	67	-4	36.6	5.26	3.0
Fayetteville.....	71	-7	35.8	4.89	2.0
Forrest City.....	72	-1	39.0	7.81	7.0
Fulton.....				9.73	
Hardy.....	69	-6	38.4	5.56	2.0
Helena a.....				7.92	
Helena b.....				7.77	1.0
Jonesboro.....	73	9	42.0	7.23	
Lacrosse.....	66	-5	36.9		
Lake Village.....	71	13	46.6	8.92	3.0
Lonoce.....	75	1	43.4	6.73	2.5
Lutherville.....	73	-6	37.2	8.04	6.0
Malvern.....	77	0	42.2	9.20	2.0
Marianna.....	70	4	42.4	8.12	4.0
Marvell.....	70	3	43.8	9.63	3.0
Mossville.....	65	3	36.0	7.46	5.9
Mountain Home.....	70	-9	36.2	4.96	2.0
Mount Nebo.....	66	0	37.8	6.08	5.0
New Gascony.....	71			11.12	2.5
Newport.....				8.39	5.0
Newport b.....	73	0	40.6	7.54	
Newport c.....	73	0	41.2	7.99	4.8
Oregon.....	70	2	36.2	5.62	2.5
Ozark.....	71	0	40.1	7.02	4.5
Paragould.....	79	-4	39.0	8.05	4.0
Perry.....	72	1	41.2	8.26	6.0
Pinebluff.....	70	2	41.4	9.44	3.0
Pocahontas.....	72	-12	37.3	7.96	0.4
Pond.....	69	-12	35.2	3.44	2.0
Prescott.....	71	5	44.8	11.82	3.4
Princeton.....	70	-2	43.6	9.15	4.0
Rison.....	69	4	40.4		
Rosadale.....	71	3	45.6	8.84	5.0
Russellville.....	72	-4	41.2	4.18	4.0
Silversprings.....	68	-4	36.5	3.15	3.3
Spiegelart.....	75	-4	40.3	8.46	4.0
Stuttgart.....	70	3	42.6	9.27	2.8
Texarkana.....	76	9	40.2	7.80	3.0
Warren.....	71	10	42.7	9.44	4.0
Washington.....	75	4	46.2	10.38	2.7
Wiggs.....	76	-2	43.0	9.90	3.2
Winchester.....	68	10	43.7	9.02	
Winslow.....	66	-4	36.0	6.60	6.0
Witts Springs.....	68	5	37.6	6.50	1.0
California.					
Angiola.....	73	18	43.2	0.11	
Azusa.....	80	28	52.2	1.57	T.
Bagdad.....	76	25	49.4	0.12	
Bakersfield.....	73	21	45.1	0.59	
Ballast Point L. H.....				2.21	
Barstow.....	79	24	43.2	0.55	1.5
Berkeley.....	62	31	46.1	2.05	T.
Bishop.....	69	4	36.4	0.20	2.5
Boca *.....	48	-30	14.2	1.50	15.0
Bodie.....	40	-36	11.3	1.04	9.0
Bowman.....	55	1	29.1	5.99	44.0
Branscomb.....				6.82	11.3
Campbell.....	67	25	44.8	1.64	
Campo.....				4.93	16.0
Cape Mendocino L. H.....				2.95	
Cedarville.....	45	-6	23.2	0.50	4.0
Chico.....	71	20	44.3	2.15	T.
Cisco *.....	45	3	22.2	2.80	28.0
Claremont.....	76	26	47.0	0.45	
Cloversdale.....	71	25	46.8	2.89	4.5
Colusa.....	66	27	44.0	1.27	2.0
Corning *.....	70	30	44.1	1.20	T.
Coronado.....	78	33	53.2	2.18	
Crescent City.....	67	29	44.8	6.06	
Crescent City L. H.....				3.34	
Cuyamaca.....	52	-1	28.2	7.31	42.0
Delano *.....	68	39	47.8	1.15	
Delta *.....	68	23	41.1	3.67	11.0
California—Cont'd.					
Drytown.....	65	20	43.0	1.70	
Dunnigan *.....	68	30	47.7	1.26	2.0
Durham *.....	67	26	44.0	1.77	T.
East Brother L. H.....				1.30	
El Cajon.....	79	29	49.8	2.97	
Elmdale.....	69	22	44.1	0.72	
Elsinore.....	82	24	49.0	2.50	
Escondido.....	79	22	46.8	3.67	
Fallbrook.....	76	28	47.4	3.33	
Folsom *.....	68	25	44.8	1.57	
Fordyce Dam.....				3.20	38.0
Fort Bragg.....				2.16	
Fort Ross.....	60	27	45.6	5.21	
Foster.....				4.31	
Georgetown.....	63	20	40.4	2.72	12.0
Gilroy (near).....	73	21	45.8	1.30	
Glendora.....				1.18	
Greenville.....	57	-11	26.6	2.36	23.5
Hanford.....	72	18	41.3	0.38	
Healdsburg.....	71	21	45.7	3.36	2.8
Hollister.....	72	19	45.2	1.36	
Humboldt L. H.....				3.21	
Idylwild.....				3.00	30.0
Imperial.....	94	26	55.8	0.06	
Indio *.....	85	28	55.0	0.00	
Iowa Hill *.....	63	24	41.0	3.39	6.5
Irvine.....	78	32	52.4		
Jackson.....	65	21	43.9	1.62	4.0
Jamestown.....	64	21	41.6	1.60	T.
Jolon.....				0.93	
Kennedy Gold Mine.....	59	16	37.8	1.80	
Kent.....	66	24	45.7	4.00	
Kernville.....				1.75	10.0
Lakeport (near).....	60	27	42.4	2.02	4.0
Lamesa.....				3.38	
Laporte *.....	56	10	28.2	3.14	29.4
Legrand.....	68	21	44.0	0.98	
Lemontcove.....	71	28	47.0	0.94	T.
Lick Observatory.....	54	14	34.9	2.20	24.0
Lime Point L. H.....				0.95	
Livermore.....	73	26	46.6	0.94	0.5
Lodi.....	65	24	43.0	1.79	
Los Gatos.....	67	29	45.9	2.51	T.
Mammoth *.....	79	31	56.4	0.00	
Manzana.....	69	14	40.4	0.96	4.0
Mare Island L. H.....				1.62	
Merced.....	70	23	42.8	0.63	
Mercury.....	72	26	49.6	3.05	

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
<i>California—Cont'd.</i>					
Rio Vista	66	28	45.0	1.47	
Riverside	82	24	48.4	0.93	T.
Roe Island L. H.				0.93	
Rohnerville	64	23	45.2	3.48	12.0
Rosewood	64	16	40.6	2.05	
Sacramento	64	26	44.6	1.86	T.
Salinas	71	24	46.4	1.38	
Salton	82	30	56.4	0.15	
San Bernardino	82	22	49.1	1.67	0.5
San Jacinto	76	22	46.2	1.37	
San Jose	72	25	47.8	1.27	T.
San Leandro	66	24	45.2	1.94	
San Luis L. H.				2.17	
San Mateo	65	32	48.0	2.45	
San Miguel	69	21	44.8	1.06	
San Miguel Island	65	31	50.0	3.92	
Santa Barbara	76	32	51.1	1.63	T.
Santa Barbara L. H.				1.67	
Santa Clara				1.52	
Santa Clara College	71	23	46.2	1.50	
Santa Cruz	73	22	46.0	2.07	
Santa Cruz L. H.				2.67	
Santa Maria	75	25	49.6	1.91	
Santa Monica	69	32	49.3	2.11	
Santa Paula	78	30	54.2	1.30	
Santa Rosa	70	21	44.8	2.58	T.
Sausalito				4.45	
Shasta	69	20	44.6	1.84	16.0
Sierra Madre	72	33	50.0	1.78	T.
Snedden				0.75	
Sonoma				2.01	T.
S. E. Farallone L. H.				1.49	
Stockton	65	24	43.5	1.12	
Storey	67	23	43.0	0.78	
Summersdale	61	4	34.0	3.70	37.0
Susanville	47	-11	17.0	1.13	15.0
Tehama	68	30	46.4	1.30	
Tejon Ranch	68	25	46.4	1.27	2.0
Trimmer				1.78	4.0
Trinidad L. H.				3.40	
Truckee	48	-28	15.8	1.00	10.0
Tulare	78	22	46.2	0.68	
Tustin	72	39	55.4	1.18	
Ukiah	70	18	43.6	2.50	4.5
Upland	78	26	47.8	2.10	
Upperlake	70	16	42.9	1.91	1.8
Upper Mattole	69	25	44.2	6.62	0.5
Vacaville	68	27	45.4	1.83	1.0
Visalia				0.60	
Volcano Springs	85	33	58.1	0.00	
Wasco	74	19	43.5	0.65	
Westpoint				4.69	31.5
West Saticoy				1.00	
Wheatland	65	25	43.4	1.66	2.0
Williams	66	32	47.1	1.34	2.0
Willits	64	24	43.4	4.15	10.0
Willow	66	25	43.9	1.35	T.
Yerba Buena L. H.				0.75	
Yuba City	68	29	47.0	1.63	1.5
Zenla	65	18	40.0	5.37	3.0
<i>Colorado.</i>					
Alford	53	-24	17.2	0.95	16.0
Ashcroft	36	-19	10.8	1.04	16.5
Blaine	63	-12	24.8	1.90	19.0
Boulder	54	-12	22.8	1.82	19.5
Boxelder				2.48	30.0
Breckenridge	29	-24	6.4	0.99	16.4
Buenavista				1.45	22.0
Canyon	57	-13	24.1	2.16	27.0
Castlerock	50	-19	19.2	1.32	14.0
Cedarledge	58	-8	22.2	1.08	17.0
Cheesman	55	-26	18.4	1.15	17.1
Cheyenne Wells	53	-10	21.0	0.79	12.0
Clearview	42	-14	17.0	1.24	21.5
Colorado Springs	50	-12	20.6	0.70	10.8
Collbran	45	-21	16.0	1.77	24.0
Delta	42	-14	16.0	0.13	1.5
Durango	47	-11	24.1	1.24	21.5
Fort Collins	46	-28	14.0	1.60	20.8
Fort Morgan	41	-20	14.6	0.45	6.0
Fox	54	-14	20.1	1.51	14.5
Fruita	45	-23	12.7	1.55	18.5
Garnett	44	-18	16.7	0.28	6.1
Gilman				1.60	23.5
Gleneyre	52	-14	19.7	1.29	14.5
Glenwood	41	-22	17.2	0.70	11.0
Greeley	45	-22	16.3	0.68	9.5
Gunnison	37	-31	7.4	0.30	5.5
Hampe	52	-13	18.7	0.76	10.8
Hoehne	50	-25	20.4	0.97	13.5
Holyoke (near)	59	-26	19.0	0.75	13.5
Husted	49	-20	17.4	0.82	12.0
Lake Moraine	40	-17	12.4	2.79	31.5
Lamar	61	-12	25.4	2.04	26.5
Laporte				1.69	22.2
Las Animas	61	-16	24.5	2.13	21.5
Lay	41	-45	6.6	0.97	24.0
Leadville (near)				1.12	20.0
<i>Colorado—Cont'd.</i>					
Leroy	40	-15	16.8	1.50	12.0
Longs Peak	40	-22	11.0	1.70	24.0
Mancos	46	-20	19.9	1.77	26.4
Marshall Pass				2.04	31.0
Meeker	43	-34	11.5	1.77	21.7
Moraine	40	-22	11.6	0.95	15.5
Pagoda	41	-26	11.7	1.91	30.0
Parachute	43	-18	17.3	1.04	17.1
Platte Canon				1.39	11.5
Rangely		-34		1.29	21.6
Rockyford	61	-15	24.8	1.05	8.0
Rogers Mesa	46	-10	17.3	0.57	9.9
Ruby				4.00	61.0
Russell	45	-19	12.7	1.61	20.5
Saguache	42	-8	19.0	0.33	5.2
Salida	48	-25	18.5	3.06	35.0
San Luis	43	-20	17.4	0.93	11.0
Santa Clara	49	-11	19.8	1.30	29.0
Silt	44	-9	19.8	1.13	22.0
Sugarloaf	44	-16	16.3	1.40	21.0
Trinidad	54	-10	24.1	1.51	20.0
Twinklakes				0.77	14.5
Vilas				2.20	22.0
Wagon Wheel	42	-40	7.2	1.47	24.0
Wallet				1.42	21.0
Waterdale	51	-25	17.4	1.69	20.5
Westcliffe	46	-17	16.4	2.40	38.1
Whitepine	33	-24	7.0	1.62	24.3
Wray	55	-13	22.0	1.98	17.5
Yuma				1.88	22.0
<i>Connecticut.</i>					
Bridgeport	55	1	31.0	5.38	11.2
Canton	58	-15	26.2	4.46	12.0
Colchester	58	-2	30.4	6.12	16.5
Falls Village				4.39	14.5
Gaylordsville				4.62	1.1
Hartford	54	-2	29.1	4.92	14.0
Hawleyville	55	-5	28.2	4.51	12.5
Lake Konomoc				5.80	
New London	50	2	31.0	4.04	13.0
North Grosvenor Dale	58	-12	27.4	5.54	
Norwalk	56	-12	29.0	4.93	10.0
South Manchester				3.71	15.0
Storrs	57	-4	27.8	5.18	17.2
Voluntown	57	-12	29.9	6.80	12.0
Wallingford				5.58	10.0
Waterbury	57	-8	29.4	4.32	13.0
West Cornwall	54	-7	26.3	4.97	16.2
West Simsbury				5.18	15.0
<i>Delaware.</i>					
Delaware City				3.23	3.0
Milford	69	6	39.2	6.82	0.5
Millsboro	69	6	37.9	6.04	T.
Newark	68	-1	33.4	4.84	4.0
Seaford	69	6	38.4	6.90	T.
<i>District of Columbia.</i>					
Distributing Reservoir	69	5	37.2	4.16	
Receiving Reservoir	70	5	36.9	4.07	
West Washington	74	2	37.4	5.93	4.4
<i>Florida.</i>					
Archer	84	26	60.8	5.58	
Avon Park	87	36	67.6	5.40	
Bartow	90	35	69.4	4.87	
Bonifay	81	23	57.0	6.06	
Brooksville	86	29	63.7	7.04	
Carrabelle	73	25	57.7	6.07	
Clermont	89	31	66.4	5.55	
De Funiak Springs	80	20	55.2	6.41	
Deland	86	28	64.0		
Eustis	88	31	65.2	5.72	
Federal Point	87	32	61.5	5.46	
Fernandina	82	29	57.0	6.49	
Flamingo	85	44	72.0	1.35	
Fort George	82	26	58.0		
Fort Meade	88	28	67.0	6.12	
Fort Myers	84	38	66.9	3.37	
Fort Pierce	88	37	67.8	10.19	
Gainesville	87	26	61.2	5.29	
Grasmere	83	29	63.8		
Huntington	90	28	63.0	5.08	
Hypoluxo	86	41	72.2	4.70	
Inverness	83	31	62.2	5.08	
Jasper	83	25	58.6	5.57	
Johnstown	82	33	63.0	3.44	
Kissimmee	86	32	65.4	5.04	
Lake City	82	25	59.8	4.55	
Macleenny	84	24	59.6	5.59	
Malabar	87	34	67.2	5.09	
Manatee	87	34	67.2	4.09	
Marco	86	42	71.0	6.14	
Marianna	78	22	55.6	5.34	
Merritt Island	83	36	65.6	6.39	
Miami	86	45	73.3	4.70	
Micanopy	83	29	60.2	5.51	
Middleburg	84	22	60.2	6.84	
Moline	78	24	55.6	12.69	
New Smyrna	85	31	63.5	5.72	
Nocatee	88	39	67.8	5.54	
<i>Florida—Cont'd.</i>					
Ocala	87	25	62.0	5.57	
Orange City	89	26	64.4	5.99	
Orlando	89	31	66.2	5.48	
Pinemount	84	23	58.0	5.51	
Plant City	86	31	65.4	4.91	
Quincy	79	21	53.4	6.02	
St. Andrews	72	23	54.4	7.34	
St. Augustine	85	26	60.8	4.47	
St. Leo	87	29	63.4	5.72	
Stephensville	84	23	58.7	5.29	
Sumner	83	26	60.3	5.24	
Switzerland	82	29	59.9	4.50	
Tallahassee	75	25	56.3	5.35	
Tarpon Springs	89	31	65.0	6.52	
Titusville	87	30	65.2	6.47	
Waukeenhah	82	22	56.4	5.70	
Wausau	83	21	57.2	6.22	
Wewahatchka	81	26	57.4	6.88	
<i>Georgia.</i>					
Adairsville	69	12	45.4	14.31	T.
Albany	78	30	56.2	4.96	T.
Alpharetta	68	12	45.8	11.95	T.
Americus	76	19	50.2	7.05	T.
Athens	68	16	45.4	10.69	
Blakely	77	15	50.8	6.05	
Bowersville	68	15	45.4	9.57	
Brent	78	16	49.6	10.70	
Butler				7.49	T.
Camak	74	16	47.3	10.26	
Canton				10.79	
Carlton				9.46	
Clayton	66	11	43.2	14.41	
Columbus	79	21	51.6	9.94	
Coney	81	23	53.6	6.68	
Covington	78	15	47.2	10.45	T.
Dahlonega	68	10	43.8	14.11	T.
Dawson	81	23	54.6		T.
Diamond	68	9	44.1	13.08	T.
Douglas	86	22	56.4	5.12	
Dublin				5.12	
Dudley	80	19	52		

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Idaho—Cont'd.					
Forney	51	-21	17.8	0.26	2.2
Garnet	48	-3	25.4	0.10	1.0
Grangeville	50	1	27.5	0.30	3.0
Lakeview	36	-20	9.2	0.80	8.0
Lost River	48	4	27.6	0.76	6.5
Moscow	41	-22	11.1	T.	T.
Murray	49	4	30.6	0.22	2.2
Oakley	45	-5	22.8	0.98	17.0
Ola	47	-11	20.0	T.	T.
Paris	46	-15	19.6	0.25	4.0
Payette	35	-33	4.6	0.90	8.0
Pollock	51	-12	23.4	0.11	...
Porter	54	8	33.2	0.31	3.0
Priest River	43	1	21.9	0.77	6.5
Riddle	48	-5	21.7	1.15	11.5
St. Maries	46	-33	11.3	0.69	4.8
Silver City	58	-5	29.8	2.21	2.2
Soldier	43	-7	19.6	0.37	5.6
Vernon	38	-37	3.8	0.62	6.7
Weston	50	-22	13.2	0.10	1.0
Illinois—Cont'd.					
Albion	60	-6	33.4	4.59	1.6
Aledo	50	-16	23.8	1.53	9.0
Alexander	56	-19	27.9	2.93	7.3
Antioch	47	-14	21.1	0.60	6.0
Ashtabula	51	-18	22.0	1.32	10.1
Astoria	53	-15	26.1	3.13	15.2
Aurora	52	-14	23.0	1.94	10.0
Benton	66	-5	36.2	4.31	2.0
Bloomington	59	-16	26.8	3.32	10.9
Cambridge	51	-15	23.2	1.85	18.1
Carlinville	60	-13	29.4	3.76	10.0
Carrollton	56	-9	29.2	3.27	...
Centralia	63	-6	33.8	3.26	3.5
Charleston	54	-12	29.2	2.97	10.5
Chester	...	...	...	3.71	3.0
Chicago Heights	...	...	...	2.62	17.0
Cisne	63	-9	34.0	3.19	1.0
Coatsburg	53	-18	25.8	1.95	8.2
Colden	68	-7	36.2	4.76	0.3
Danville	56	-12	27.1	...	...
Decatur	50	-18	27.8	4.13	14.4
Dixon	54	-14	21.6	0.90	6.0
Dwight	60	-12	25.6	3.17	25.0
Effingham	65	-11	32.6	3.55	11.0
Equality	65	-4	36.2	4.44	3.2
Fandon	50	-17	26.4	1.48	8.0
Flora	61	-2	33.8	2.02	2.4
Friendgrove	61	-5	33.8	5.15	1.9
Galva	51	-18	23.6	1.95	14.5
Grafton	...	...	...	3.28	7.5
Greenville	61	-11	31.2	3.48	8.3
Griggsville	50	-16	28.2	2.62	...
Halfway	65	-4	35.6	4.65	3.0
Halliday	67	-5	35.8	3.65	...
Henry	53	-19	25.8	2.59	15.0
Hillsboro	61	-13	30.5	3.16	9.0
Hoopeston	52	-17	26.8	3.03	16.0
Joliet	50	-12	23.1	2.92	14.4
Kishwaukee	52	-18	21.3	1.19	9.0
Knoxville	52	-18	23.0	1.72	7.0
Lagrange	48	-12	28.6	2.90	24.5
Lamar	50	-18	25.0	2.13	8.5
Lanark	51	-17	20.8	1.90	9.4
La Salle	54	-15	25.0	1.27	...
Leamington	...	...	...	2.47	7.5
McLeansboro	64	-5	34.3	4.86	2.0
Martinton	52	-15	25.2	2.00	13.0
Mascoutah	60	-6	32.0	4.74	6.5
Mattoon	68	-8	33.5	1.95	10.5
Minook	55	-16	24.2	2.16	8.5
Monmouth	52	-18	22.8	1.66	8.3
Monticello	60	-16	25.8	1.50	24.0
Morris	51	-18	22.7	1.47	8.2
Morrisville	60	-14	28.8	3.25	11.2
Mount Carmel	...	...	...	5.46	6.4
Mount Pleasant	57	-17	27.4	3.06	12.0
Mount Vernon	64	-1	35.8	3.37	2.5
New Burnside	65	-6	35.6	4.90	2.0
Olney	62	-7	33.4	4.02	2.8
Ottawa	57	-13	27.0	2.35	14.5
Palestine	55	-9	30.3	3.97	3.0
Pana	58	-17	27.0	4.15	14.5
Paris	55	-12	28.4	2.45	...
Peoria	...	...	...	2.50	7.6
Peoria	54	-13	27.1	1.70	4.5
Philo	55	-15	26.2	3.16	15.0
Plumhill	64	-6	33.5	2.89	2.5
Pontiac	57	-14	26.7	3.23	12.0
Rantoul	55	-17	26.6	3.23	17.0
Raum	64	-10	35.6	5.22	6.0
Riley	47	-15	22.0	1.33	10.2
Robinson	59	-10	31.3	5.10	6.0
Rushville	52	-17	26.2	1.50	5.5
St. Charles	51	-14	23.8	2.55	8.0
St. John	65	-4	34.2	3.64	T.
Shobonier	57	-8	31.9	2.51	4.0
Indiana—Cont'd.					
Streator	50	-15	23.4	2.52	5.0
Sullivan	56	-16	28.4	2.53	11.5
Sycamore	50	-16	23.4	1.87	12.5
Tilden	65	-7	33.4	2.89	3.8
Tiskilwa	49	-19	22.2	2.95	15.0
Tuscola	56	-14	27.4	3.20	10.0
Urbana	55	-17	25.6	2.40	12.0
Walnut	52	-17	24.4	1.88	14.1
Winchester	55	-13	27.8	3.89	7.8
Winnebago	52	-16	22.3	1.81	7.0
Yorkville	52	-15	23.2	1.78	5.5
Zion	50	-16	23.2	1.17	9.0
Iowa—Cont'd.					
Bedford	52	-17	20.8	1.13	4.8
Belleplaine	48	-15	20.0	2.32	15.0
Bonaparte	49	-17	23.1	1.92	11.5
Britt	43	-19	16.6	0.63	3.4
Buckingham	...	...	...	0.61	4.2
Burlington	50	-18	25.0	1.98	6.9
Carroll	44	-18	19.0	1.29	9.5
Cedar Rapids	48	-12	22.4	0.74	8.0
Chariton	53	-14	22.5	1.14	3.2
Charles City	44	-17	19.8	0.50	2.4
Clarinda	52	-14	22.4	1.18	9.0
Clearlake	42	-21	16.0	0.62	3.8
Clinton	52	-16	23.4	1.29	9.5
College Springs	51	-14	22.0	0.96	5.0
Columbus Junction	47	-15	22.5	1.42	14.6
Corning	48	-15	20.9	1.05	8.0
Corydon	54	-15	23.5	1.55	6.3
Council Bluffs	69	-13	23.1	3.23	28.8
Cumberland	...	...	...	1.00	10.0
Danville	...	...	...	3.35	...
Decorah	43	-18	18.1	1.09	9.2
Delaware	46	-16	19.2	0.77	2.2
Denison	50	-20	18.0	1.45	9.5
Dows	42	-20	18.0	1.45	11.0
Earlham	46	-15	18.1	1.57	11.8
Eldon	56	-20	24.4	1.14	8.9
Elkader	52	-15	20.6	1.46	12.0
Estherville	40	-21	14.2	1.01	9.0
Fayette	47	-17	18.1	1.22	8.7
Forest City	40	-20	15.7	0.80	4.0
Fort Dodge	47	-21	16.8	0.83	5.3
Fort Madison	...	...	...	1.03	7.0
Galva	43	-20	16.9	0.30	3.0
Gilman	...	...	...	0.83	4.0
Grand Meadow	44	-18	18.8	1.18	6.2
Greene	44	-16	19.1	0.81	5.0
Greenfield	47	-16	20.6	1.13	9.8
Grinnell	45	-13	20.8	1.92	11.5
Grinnell (near)	46	-15	20.4	1.55	11.0
Grundy Center	45	-15	19.8	0.90	5.5
Guthrie Center	44	-17	20.0	1.19	7.0
Hampton	46	-17	19.0	1.52	13.9
Hanlontown	45	-20	16.4	...	...
Harlan	43	-18	18.1	1.27	9.0
Harmon	...	...	...	0.77	...
Hopeville	58	-17	18.2	0.43	T.
Humboldt	48	-20	17.9	1.37	4.2
Idagrove	45	-15	19.0	0.82	6.8
Independence	49	-13	22.5	2.58	7.5
Indianola	49	-13	22.2	1.03	7.0
Iowa City	42	-16	17.0	1.35	9.5
Iowa Falls	42	-16	17.0	0.98	6.8
Jefferson	50	-15	23.0	2.09	11.0
Keosauqua	...	...	...	1.04	5.0
Lacota	45	-20	16.4	1.13	10.4
Larrabee	44	-19	15.8	1.04	7.3
Leclaire	44	-19	15.8	...	...
Lemars	44	-17	20.4	0.98	5.8
Lenox	52	-12	23.2	1.03	5.6
Leon	45	-17	20.2	1.46	14.0
Logan	...	...	...	0.90	6.5
Maple Valley	49	-15	22.2	0.82	...
Maquoketa	49	-14	22.0	1.14	8.5
Marshalltown	44	-15	20.4	1.11	7.4
Mason City	47	-15	21.8	1.50	7.0
Monticello	47	-16	22.8	1.08	10.8
Mount Pleasant	55	-16	24.3	0.32	3.2
Mount Vernon	52	-15	21.6	1.05	6.7
New Hampton	43	-19	17.2	1.65	16.0
Newton	45	-17	20.6	1.12	6.5
Northwood	42	-19	17.8	1.72	4.0
Odebolt	44	-16	18.2	0.79	4.0
Ogden	46	-17	20.0	0.95	6.5
Olin	48	-15	21.5	1.64	5.8
Onawa	48	-18	17.6	1.05	6.9
Osage	43	-18	17.6	0.90	9.0
Oscola	52	-15	21.6	0.79	7.8
Oskaloosa	49	-14	21.4	2.51	15.1
Ottumwa	50	-9	25.0	1.04	6.9
Pacific Junction	44	-15	20.8	...	...
Pella	48	-14	21.8	1.10	7.8
Perry	45	-14	20.2	1.10	3.5
Plover	41	-20	16.0	0.57	9.0
Red Oak	44	-10	23.2	1.70	14.5
Ridgeway	48	-18	19.8	2.05	9.0
Rockwell City	45	-18	19.2	0.60	1.0
Sac City	41	-17	18.0	1.10	7.5
St. Charles	51	-13	22.5	1.15	6.8
Seranton	42	-15	18.2	1.37	10.0
Sheldon	42	-20	15.2	1.57	12.7
Sibley	42	-18	15.9	0.50	5.0
Sigourney	51	-14	23.3	1.40	9.5
Sioux Center	40	-21	15.0	0.90	7.0
Spirit Lake	40	-20	14.6	1.00	10.0
Stockport	...	...	...	1.56	6.0
Storm Lake	40	-20	16.5	1.11	5.0
Thurman	44	-15	20.0	2.45	...
Tipton	48	-12	23.3	1.17	7.5

TABLE II.—*Climatological record of voluntary and other cooperating observers—Continued.*

Stations.	Temperature. (Fahrenheit.)			Precipitation.		Stations.	Temperature. (Fahrenheit.)			Precipitation.		Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.		Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.		Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
<i>Iowa—Cont'd.</i>						<i>Kentucky.</i>						<i>Maine—Cont'd.</i>					
Toledo	45	-14	20.9	0.97	8.0	Alpha	68	-6	40.9	10.50	5.5	Mansfield	46	-12	20.7	3.27	25.0
Villisca	48	-15	21.0	1.62	14.5	Anchorage	62	-12	34.2	6.07	6.5	Millinocket	62	-12	21.2	3.30	24.0
Vinton *1	47	-14	21.4	0.78	6.0	Baristown	70	-9	37.4	8.52	5.0	Montague	59	-20	23.8	3.49	22.5
Wapello	47	-11	23.6	1.56	11.5	Beattyville	68	-12	37.7	7.08	6.0	North Bridgton	59	-20	23.8	4.02	21.0
Washington	47	-17	20.7	1.43	12.5	Berea	68	-12	37.7	7.08	6.0	Orono	50	-16	19.8	3.48	21.0
Washta	47	-15	20.2	1.20	9.0	Blandville	71	-4	36.1	7.78	7.2	Rumford Falls	52	-20	21.0	3.89	26.8
Waterloo	47	-15	20.2	1.37	10.2	Bowling Green	68	-4	39.4	8.37	11.0	Solon	50	-16	19.8	2.81	21.0
Waukeo	45	-16	18.9	1.38	11.0	Burnside	65	-5	37.4	7.98	5.0	The Forks	46	-37	11.2	3.63	29.0
Waverly	43	-19	16.4	1.49	11.4	Carrollton	70	-10	37.2	6.29	6.0	Vanburen	52	0	27.6	3.81	54.0
Westbend	44	-18	19.3	0.99	5.8	Cattlettsburg	74	-5	38.4	7.50	6.0	Vanceboro	50	-15	21.0	3.30	22.0
Westbranch	47	-16	22.3	1.25	12.0	Earlington	70	-10	39.4	8.65	6.5	Winslow	68	-8	31.0	6.20	2.0
Whitten	47	-16	22.3	1.90	7.0	Edmonton	68	-15	38.4	9.81	6.0	Bachmans Valley	68	-8	31.0	8.20	10.5
Wilton Junction	52	-14	21.6	0.95	6.0	Eubank	65	-10	38.6	5.67	6.0	Boottcherville	71	-5	32.5	6.17	10.0
Winterset				1.72	6.2	Falmouth	66	-8	36.6	8.13	6.0	Boonsboro a	67	6	39.0	6.56	0.5
Woodburn						Fords Ferry	68	-2	37.8	6.80	8.0	Cambridge	71	0	36.0	4.98	1.5
<i>Kansas.</i>						Frankfort	69	-8	36.0	8.48	5.8	Chase	73	3	37.2	4.16	1.5
Abilene	58	-14	21.8	0.81	7.5	Franklin	66	-3	34.5	5.66	5.6	Cheltenham	67	5	35.8	5.55	0.8
Achilles	59	-12	23.6	2.11	13.3	Greensburg	68	-3	37.8	7.25	4.7	Chestertown	68	-11	34.0	2.74	9.2
Alton	64	-11	26.9	1.20	5.5	Henderson	75	-6	41.6	8.20	6.0	Chewsville	67	-2	33.2	4.42	8.0
Anthony	61	-22	22.7	1.22	5.5	Highbridge	69	-10	35.8	8.19	5.0	Clearspring	67	3	36.8	5.46	2.0
Atchison	55	-10	24.5	0.60	6.0	Hopkinsville	72	-16	40.9	9.40	4.5	Coleman	72	-2	35.2	4.34	1.6
Baker	66	-18	30.2	1.58	3.0	Irrington	70	-8	39.6	7.58	6.5	Collegepark	68	-7	34.2	5.83	9.5
Beloit	67	-11	32.3	2.83	5.0	Jackson	69	-9	35.8	7.58	7.0	Colora	66	-4	34.2	4.30	10.0
Burlington	66	-18	30.2	1.58	3.0	Leitchfield	68	-1	40.1	8.94	4.0	Darlington	69	-9	28.5	5.23	15.5
Chanute	67	-11	32.3	2.83	5.0	Loretto	65	-7	37.0	7.00	6.0	Deerpark	69	6	38.4	4.15	0.8
Clay Center	60	-11	22.2	1.13	2.0	Manchester	67	-3	38.2	5.64	5.2	Denton	69	6	38.4	5.38	0.5
Colby	59	-11	22														

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.		Stations.	Temperature. (Fahrenheit.)			Precipitation.		Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.		Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.		Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Michigan—Cont'd.						Michigan—Cont'd.						Mississippi—Cont'd.					
Arbela	45	-11	23.2	3.97	15.0	Vassar	46	-10	24.8	2.21	7.5	Leakesville	76	20	52.5	9.47	
Baldwin	44	-21	19.8	2.45	11.0	Wasopi	45	-10	23.9	4.12	18.5	Louisville	74	8	47.8	15.89	1.0
Ball Mountain	45	-9	23.2	2.69	13.3	Waverly	50	-10	25.2	2.02	17.0	Macon	77	14	46.6	10.44	
Baraga	49	-28	15.4			Webberville	44	-18	23.2	2.82	17.0	Magnolia	75	19	52.6	10.13	T
Battlecreek	45	-12	22.4	1.66	12.0	West Branch	42	-13	17.8	1.64	15.5	Natchez	79	20	52.6	14.25	
Bay City	42	-12	21.3	2.55	17.0	Wetmore	50	-22	15.4	0.70	7.0	Nittayuma	76	12	46.4	14.08	
Benzonia	43	-9	21.9	2.94	16.8	Whitecloud	44	-20	18.3	1.82	17.5	Okolona	69	6	43.4	5.98	
Berlin	45	-8	23.2	3.08	15.6	Whitefish Point	43	-20	18.3	1.82	17.5	Patmos				13.40	T.
Berrien Springs	45	-8	25.2	3.10	29.0	Ypsilanti	50	-10	24.2	3.37	13.7	Pearlington	78	24	55.2	8.67	
Big Rapids	45	-14	19.8	2.82	10.5	Minnesota.						Pittsboro	74	6	46.6	8.26	1.0
Birmingham	47	-9	23.6	3.00	15.5	Ada	39	-35	7.2	0.40	3.6	Pontotoc	78	3	45.9	6.83	3.0
Boon	43	-19	16.1	1.80	9.1	Albert Lea	40	-21	12.3	0.70	7.0	Poplarville	76	20	53.4	9.25	T.
Calumet	40	-19	14.8	2.45	24.0	Alexandria	40	-32	9.0	0.46	4.2	Port Gibson				13.88	
Carsonville	50	0	22.1	1.06	9.0	Angus	35	-35	0.5	0.30	3.0	Ripley	67	0	42.7	8.55	4.0
Cassopolis	42	-15	20.4	3.55	17.5	Ashby	38	-30	8.4	0.36	4.2	Shoccoe	79	15	48.8	11.64	2.0
Charlevoix	47	-16	23.2	1.30	10.0	Beardsley	40	-31	9.3	1.00	T.	Stonington				11.10	T.
Charlotte	46	-16	23.2			Beaulieu	35	-41	2.4			Suffolk	78	17	51.4	13.26	T.
Chatham	50	-16	15.4	2.45	18.5	Bemidji	41	-39	10.4	0.79		Swartwout	73	26	56.0	8.27	
Cheboygan	51	-12	19.0	2.00	20.0	Bird Island	41	-26	12.6	0.13	T.	Thornton	75	26	49.0	13.44	
Clinton	50	-11	25.1	2.81	12.8	Bloomington	39	-22	13.6	0.70	5.0	Tupelo	75	4	45.6	8.45	
Coldwater	50	-12	26.2	1.20	12.0	Caledonia	42	-22	16.0	0.76	4.0	University	70	3	45.1	8.80	3.0
Deerpark	43	-10	19.6	3.50	29.0	Collegeville	43	-25	14.8	0.48	3.7	Walnutgrove	80	15	47.8	11.22	0.5
Detour	43	-16	18.2	1.79	14.0	Crookston	35	-30	3.6	0.20	2.0	Waterville	76	4	43.4	9.97	4.0
Dundee	52	-8	24.9	3.74	16.0	Deephaven				0.14		Waynesboro	79	19	52.2	8.96	
Eagle Harbor	45	-15	17.8	2.30	23.0	Detroit	38	-47	1.5	0.29		Westpoint	77	12	50.0	6.06	2.0
East Tawas	49	-10	22.8	1.61		Duluth (sub station)	37	-29	12.2	0.61	6.4	Woodville	76	19	52.4	9.97	T.
Eloise	50	-11	24.8	3.94	19.3	Faribault	42	-24	14.4	0.62	5.2	Yazoo City	77	12	48.8	12.96	T.
Ewen	44	-35	11.9	0.70	7.0	Farmington	40	-28	13.2	0.35	1.5	Missouri.					
Fennville	45	-8	25.1	2.25	17.0	Fergus Falls	40	-31	7.2	0.27	2.7	Appleton City	59	-13	30.3	3.15	5.0
Fitchburg	46	-12	22.6	3.45	19.5	Floodwood	42	-40	8.8	0.05	0.5	Arthur	66	-15	32.3	3.87	3.0
Flint	44	-11	22.8	2.74	11.5	Glencoe	42	-28	13.5	0.05	T.	Avalon	61	-15	27.4	2.10	10.5
Frankfort	45	-10	24.2	1.50	10.0	Grand Meadow	44	-21	14.4	1.20	7.8	Bethany	55	-18	24.5	1.08	7.5
Gaylord	43	-20	16.8	1.75	17.5	Hallack	38	-41	2.2	0.02	0.2	Birchtree	69	-8	35.0	4.00	2.0
Gladwin	43	-12	19.0	1.75	3.5	Lake Winnibigoshish	40	-38	7.5	0.67	7.0	Boonville				1.98	9.8
Grand Marais	45	-6	20.5	1.85	18.0	Leech	42	-42	6.6	0.57	4.2	Brunswick	63	-15	25.6	2.05	8.5
Grand Rapids	50	-7	24.7	1.08	5.3	Long Prairie	43	-35	9.4	0.46	4.8	Carrollton	62	-19	27.7	2.02	8.0
Grape	53	-9	25.0	3.49	13.5	Luverne	40	-20	13.3	0.76	7.0	Caruthersville	74	-3	40.6	6.03	2.8
Grayling	45	-16	17.4	3.45	20.0	Lynd	43	-23	13.2	0.52	4.0	Conception	63	-16	24.3	1.35	9.0
Hagar	51	-14	26.6	2.76	14.4	Mapleplain	42	-27	12.2	0.79	5.1	Darksdale	60	-18	26.7	1.52	6.8
Hanover	46	-16	22.6	3.02	5.5	Milaca	39	-35	8.2	0.36	6.0	Dean	69	-11	34.8	4.06	2.0
Harbor Beach	44	-8	23.4	1.51	12.5	Milan	39	-31	9.0	0.55	5.5	Desoto	67	-3	32.6	2.65	2.2
Harrison	39	-19	15.6	1.73	10.0	Minneapolis b	41	-25	12.6	0.54	1.7	Downing				1.27	9.5
Harrisonville	43	-10	19.4	2.88	19.0	Montevideo	41	-32	7.6	0.37	3.0	Edgehill	68	-10	34.1	4.33	2.0
Hart	40	-5	20.7	1.91	17.0	Morris	42	-30	9.0	0.50	5.0	Edwards	67	-24	30.2	2.91	4.0
Hastings	49	-18	24.0	3.05	16.3	Mount Iron	43	-34	8.2	1.07	10.8	Eightmile				1.60	8.0
Hayes	46	-8	22.5	3.45	25.0	New London	44	-33	9.4	0.28	0.8	Fairport				1.33	7.4
Highland Station				3.85	11.0	New Richland	42	-21	17.0	0.80	8.0	Fayette	62	-14	29.2	2.53	11.0
Hillsdale	47	-12	23.6	3.86	19.7	New Ulm	47	-19	14.6	0.40	1.0	Fulton	64	-14	30.1	3.26	4.5
Humboldt	45	-39	9.4	0.10	1.0	Park Rapids	39	-38	4.9	0.55	5.5	Galena				4.31	2.2
Ionia	45	-12	21.2			Pine River	45	-42	5.0	0.52	9.0	Gallatin	55	-10	27.9	1.91	9.5
Iron Mountain	50	-20	16.6	1.46	9.0	Pipestone	39	-22	14.8	0.61	1.1	Glasgow	62	-16	27.1	2.70	13.5
Iron River	46	-26	12.1	0.60	4.0	Pleasant Mounds	43	-18	16.5	0.46	5.0	Gorin				1.45	3.7
Ironwood	43	-28	13.8	0.84	7.1	Pokegama Falls	43	-59	4.4	0.98	8.5	Grant City	56	-13	23.6	0.53	2.9
Ishpeming	45	-23	14.0	1.40	13.0	Redwings				0.59		Halfway	65	-9	34.0	4.45	3.0
Ivan	44	-11	19.2	2.14	15.5	Redwings	40	-23	14.1	0.69	3.5	Harrisonville	61	-22	26.0	3.06	8.3
Jackson	47	-9	25.6	3.56	12.5	Reeds				0.72	9.0	Hazlehurst				1.65	5.5
Jeddo	43	-8	22.5	2.47	12.5	Rolling Green	45	-19	14.5	0.80	8.0	Hermann				2.74	0.7
Kalamazoo	45	-10	23.6	2.37	20.9	St. Cloud	42	-30	10.8	0.33	5.0	Houston	68	-6	34.3	3.42	1.0
Lake City	43	-10	18.0			St. Peter	45	-20	16.4	T.	0.5	Huntsville	60	-15	28.4	2.47	9.0
Lansing	46	-12	22.9	3.10	20.7	Sandy Lake Dam	40	-41	6.9	0.81	8.1	Ironton	68	-8	33.3	3.47	1.5
Lapeer	45	-11	23.6			Shakopee	42	-23	13.4	0.45	3.5	Jackson	68	-5	36.6	5.01	4.2
Lincoln	49	1	20.5	0.70	7.0	Thief River Falls	34	-38	4.0	0.10	1.0	Jefferson City	67	-12	28.5	3.09	5.2
Ludington	45			2.40	19.0	Tower	45	-39	7.2	1.10	11.0	Joplin	67	-2	34.0	2.98	4.0
Mackinac Island	43	-13	19.2	2.68	26.0	Two Harbors	39	-28	10.4	0.42	3.0	Kidder	61	-16	25.4	1.29	4.2
Mackinaw	47	-12	19.1	0.84	5.9	Wabasha	46	-22	16.0	1.10	8.0	Koshkonong	69	-7	36.7	6.10	1.3
Mancelona	44	-11	20.6	2.40	20.0	Warroad				0.05	0.5	Lamar	67	-9	32.6	2.85	3.0
Manistee	38			1.30	13.0	Willow River	37	-37	8.6	2.56	19.6	Lamonte				2.33	5.0
Manistiquie	43	-15	19.6	1.00	7.0	Winnepago City	42	-20	14.8	0.86	5.4	Lebanon	66	-10	31.9	3.88	1.5
Midland	46	-16	24.0	1.51	11.6	Winona	45	-21	15.9	1.42	10.5	Lexington	63	-13	28.2	1.95	7.0
Mio	44																

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Temperature. (Fahrenheit.)						Precipitation.		Temperature. (Fahrenheit.)						Precipitation.		Temperature. (Fahrenheit.)						Precipitation.	
Maximum.		Minimum.		Mean.		Rain and melted snow.	Total depth of snow.	Maximum.		Minimum.		Mean.		Rain and melted snow.	Total depth of snow.	Maximum.		Minimum.		Mean.		Rain and melted snow.	Total depth of snow.
Stations.								Stations.								Stations.							
Missouri—Cont'd.								Nebraska—Cont'd.								Nevada—Cont'd.							
St. Charles	63	-14	31.2	2.87	7.0	Edgar				1.25	12.5	Battle Mountain	60	-20	21.4	0.20	3.5						
St. Joseph				1.10	4.0	Ericson				1.70	17.0	Beowawe *1	55	-10	23.0	T.							
Sarco				3.29		Ewing				1.02	10.2	Belmont	40	-11	19.0	0.02	0.2						
Sedalia	63	-16	29.8	2.93	8.0	Fairbury	54	-15	20.4	1.17	7.7	Candelaria	50	2	27.4	1.20	12.0						
Seymour	66	-8	32.0	3.85	2.0	Fairmont	50	-14	19.2	1.37	14.5	Carlin *1	34	-18	15.2	1.30	13.0						
Shelbina				2.10	8.0	Fort Robinson	48	-21	16.6	0.60	6.0	Carson City	51	-16	21.8	0.69	9.4						
Sikeston	66	-3	37.5	6.72	4.3	Franklin	57	-16	21.8	1.50	15.0	Cranes Ranch				0.34							
Steffenville	55	-16	27.0	2.00	10.5	Freemont	50	-15	17.4	0.97		Dyer	65	3	29.7	0.11	2.2						
Sublett	56	-17	25.4	1.42	8.2	Fullerton				2.80	22.0	Elko	42	-18	19.2	0.12	1.2						
Trenton	55	-12	25.5	1.44	4.2	Geneva	53	-15	19.8	1.12	11.2	Ely	45	-20	15.3	0.40	4.0						
Unionville	54	-14	22.8	2.16	5.5	Genoa (near)	46	-18	18.8	1.03	10.3	Eureka	47	-18	19.5	1.20	12.0						
Vichy	66	-18	31.0	3.17	3.1	Gering	49	-20	19.7	0.89	8.9	Fenelon *1	48	-18	15.2	1.35	13.5						
Warrensburg	64	-15	30.0	2.51	10.5	Gordon				0.65	6.5	Golconda *1	52	-20	21.5	0.60	6.0						
Warrenton	64	-11	27.8	3.27	6.6	Gosper				1.40	14.0	Halleck *1	46	-22	17.0	0.50	5.0						
Wheatland				2.98	3.0	Gothenburg	50	-20	20.0	2.20	22.0	Hamilton	53	-13	20.6	1.00	10.0						
Willowsprings	69	-9	34.2	4.53	1.0	Grand Island b	49	-17	19.6	2.09	20.9	Hawthorne	58	5	27.7	0.35	4.0						
Windsor	65	-20	30.6	2.62	6.0	Greeley				1.10	11.0	Humboldt	43	-11	16.2	0.01	0.1						
Zeitonia	70	-12	34.6	4.41	3.0	Guide Rock				1.65	16.5	Lee				0.82	11.0						
Montana.						Halsey				1.04	10.4	Lewers Ranch	52	-7	23.4	1.63	14.4						
Adel	46	-26	17.8	1.20	12.0	Hartington	46	-21	16.0	1.20	12.0	Lovelocks	50	-10	24.0	0.05	0.5						
Anaconda	50	-10	20.2	0.06	0.7	Harvard	50	-15	19.4	2.30	23.0	Martins	54	-15	22.9	0.92	6.0						
Augusta	55	-21	24.0	0.18	2.0	Hastings *1	52	-13	19.0	2.50	25.5	Monitor Mill	52	-22	16.2	0.15	1.8						
Billings	52	1	24.8			Hayes Center				3.83	38.3	Morey	50	-9	21.6	0.69	10.0						
Boulder	48	-12	20.2	0.37	2.0	Hay Springs	43	-22	14.3	1.20	12.0	Palisade	47	-17	17.8	0.10	1.0						
Bozeman	44	-12	18.2	0.33		Hebron	52	-11	22.6	1.34	8.5	Palmetto	55	-9	25.8	1.00	10.0						
Butte	45	-9	20.7	0.05	0.5	Hickman				0.65	6.5	Potts	45	-29	13.0	0.38	4.2						
Canyon Ferry	49	-15	18.8	0.52	4.5	Holbrook				2.74	21.5	Reno State University	44	-11	20.1	1.00	7.3						
Chinook	48	-27	15.6			Holdrege	54	-17	21.0	2.30	23.0	Rioville	86	20	44.6	0.24	0.0						
Columbia Falls	52	-7	21.9	0.62	6.2	Hooper *1	44	-13	18.3	0.78	6.0	Silverpeak	54	1	29.1	0.30	3.0						
Crow Agency	51	-11	20.8	1.20	12.0	Imperial	56	-18	21.1	2.75	29.5	Sodaville	56	5	28.1	T.	T.						
Culbertson	42	-37	4.1	0.17	1.5	Johnstown				0.90	9.0	Tecoma	42	-22	11.8	0.33	2.0						
Deer Lodge	43	-16	17.4	0.05	0.5	Kearney	52	-16	22.4	2.25	22.5	Toano *1	49	-19	14.6	0.90	9.0						
Dillon	49	-9	21.4	0.07	0.7	Kennedy	48	-18	20.5	2.72	23.0	Wabaska	56	-4	26.4	0.02	0.2						
Ekalaka	42	-30	12.8	0.60	6.0	Kimball	48	-17	17.0	1.00	10.0	Wadsworth	50	-3	26.5	0.22	2.2						
Fort Logan	50	-18	20.0	T.		Kirkwood	48	-22	17.0	1.00	10.0	Wells *1	48	-32	11.4	1.60	16.0						
Glasgow	44	-38	6.5	0.07	2.4	Lexington	51	-19	18.0	1.55	15.5	Wood	47	-21	14.7	0.81	8.1						
Glendive	36	-43	2.1	0.40	4.0	Laclede	49	-16	20.0	2.25	19.5	New Hampshire.											
Great Falls	55	-18	25.9	0.35	3.5	Lodgepole	50	-19	17.0	1.80	18.0	Alstead	50	-11	25.1	4.02	18.0						
Hamilton	49	-2	25.5	0.06	2.0	Loup	51	-20	18.5	0.70	7.0	Berlin Mills	63	-33	18.0	3.06	21.4						
Kipp	46	-21	18.0	0.50	5.0	Lynch	48	-22	15.6	1.84	18.8	Bethlehem	57	-12	21.5	3.23	25.0						
Lame Deer	60	-20	19.8	0.80	8.0	Lyons				1.07	8.7	Brookline *1	60	-22	26.4	4.00	15.0						
Lewistown	50	-17	19.4	1.30	13.0	McCook *1	53	-9	23.6	2.32	23.2	Chatham	53	-25	19.4	4.45	28.0						
Livingston	46	-23	15.8	0.01	0.1	McCool Junction				1.21	11.0	Concord	56	-24	24.0	4.00	19.5						
Manhattan	45	-17	19.0			Madison	57	-15	19.4	0.85	8.5	Durham	60	-7	28.0	4.32	12.0						
Marysville	42	-17	20.6			Madrid	43	-20	18.2	2.10	21.0	Franklin Falls	55	-17	23.9	3.98	24.2						
Missoula	48	-5	22.8	0.29	3.5	Marquette				1.45	14.5	Grafton	58	-33	21.2	3.34	25.0						
Ovando	46	-25	14.7	0.30	3.0	Mason				0.60	6.0	Hanover	55	-24	25.3	3.11	23.5						
Parrot	51	-6	22.6			Minden b.	49	-19	19.2	2.61	27.7	Keene	56	-20	24.2	3.58	16.5						
Plains	48	1	24.2	0.10	1.0	Mourne				1.07	8.5	Littleton	51	-14	21.4	3.61	21.0						
Poplar	43	-40	3.4	0.20	2.0	Nebraska City c	48	-12	23.3	1.60	10.5	Manchester				4.01	12.5						
Red Lodge	45	-19	16.2	1.61	23.7	Norfolk	52	-20	17.0	1.36	13.0	Nashua	60	-20	26.6	4.18	16.5						
Ridgeland	42	-45	3.2	0.80	8.0	North Loup	55	-15	20.6	1.40	14.0	Newton	60	-13	27.0	3.03	15.0						
St. Pauls	51	-19	19.7	0.33	8.5	Oakdale	51	-16	16.0	0.82	8.5	North Stratford				2.74	24.4						
St. Peter	49	-25	20.2	0.93	17.0	Odell				1.60	8.0	Peterboro	54	-22	23.5	4.41	20.5						
Springbrook	39	-39	7.8	0.78	7.8	O'Neill	50	-21	16.1	1.32	13.2	Plymouth	53	-27	22.2	3.14	22.2						
Summit	44	-23	17.6	1.00	10.0	Ord	46	-18	17.9	1.21		Sanbornston	54	-19	22.4	3.72	24.0						
Toston	50	-10	19.8	0.02	0.2	Osceola				2.30	23.0	Stratford	52	-23	19.2	2.84	16.0						
Troy	54	-5	25.0	1.09	7.5	Palmer				1.30	13.0	West Stewartstown				3.84	30.5						
Twin Bridges	46	-12	18.2	T.		Palmyra *1	48	-14	20.6	0.90	9.0	New Jersey.											
Twodot	45	0	19.0	0.10	1.0	Pawnee City				1.20	5.1	Asbury Park	61	0	35.2	4.70	6.8						
Utica	53	-20	21.4	0.24	2.5	Plattsmouth	48	-13	19.4	0.95	9.5	Barnegat	68	1	35.8	5.62	1.0						
Winston	43	-11	19.0	0.62	6.2																		

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Temperature. (Fahrenheit.)						Precipitation.		Temperature. (Fahrenheit.)						Precipitation.		Temperature. (Fahrenheit.)						Precipitation.													
Maximum.			Minimum.			Mean.			Rain and melted snow.	Total depth of snow.	Maximum.			Minimum.			Mean.			Rain and melted snow.	Total depth of snow.	Maximum.			Minimum.			Mean.			Rain and melted snow.	Total depth of snow.			
Stations.			Stations.			Stations.					Stations.			Stations.			Stations.																		
New Jersey—Cont'd.												New York—Cont'd.												North Carolina—Cont'd.											
Salem	68	3	36.6	5.22	2.0	Littlefalls, City Res.	65	-8	23.6	3.19	19.0	Settle	70	13	44.4	7.32	T.																		
Somerville	68	-7	31.8	4.77	8.0	Lockport	54	-2	27.5	2.39	1.5	Sloan	75	20	50.4	4.31																			
South Orange	65	-3	32.0	5.35	9.5	Lowville	51	-18	21.8	3.94	19.0	Soapstone Mount	71	10	43.5	6.20	T.																		
Sussex	61	-5	30.4	4.36	13.0	Lyndonville				2.41		Southern Pines a	73	17	48.3	6.34																			
Toms River	66	0	35.3	5.02	0.5	Middletown	58	-2	29.4	4.31	13.2	Southern Pines b	71	18	48.5	7.30																			
Trenton	69	2	37.9	5.27	9.0	Mohonk Lake	56	-6	28.0	5.56	15.0	Southport	69	23	51.3	3.24																			
Tuckerton	66	3	36.0	6.28	0.8	Moira	58	-13	22.2	3.33	23.0	Springhope*1	72	17	46.9	4.68																			
Vineland	65	3	36.5	5.38	1.0	Mount Etrick	56	-10	24.8			Statesville	70	11	43.4	9.90																			
Woodbine	65	1	36.6	6.60	0.5	Newark Valley				2.76	12.0	Tarboro	74	17	47.4	6.27																			
Woodstown				4.84		New Lisbon	56	-13	22.6	3.19	17.0	Washington	75	21	50.8	4.87																			
New Mexico.						North Hammond				2.62	21.0	Waynesville	69	6	42.2	8.65																			
Alamogordo	67	8	39.0	1.00	5.5	North Lake	52	-14	24.1	7.40	53.0	Weldon a	69	17	42.6	4.51																			
Alburt	67	-6	30.2	1.38	20.0	Nunda	59	-5	28.5	2.10	11.5	Weldon b				4.56																			
Albuquerque	58	-4	34.6	0.41	3.0	Ogdensburg	51	-14	21.3	2.77	10.7	North Dakota.																							
Alma	69	6	36.3	0.30	3.0	Old Chatham				3.90	10.0	Amenia	38	-32	5.8	0.32	3.2																		
Arabella	63	8	35.5	1.27	12.5	Onesonta	58	-7	26.4	3.29	21.0	Ashley	38	-37	3.6																				
Arbuckle				1.45	15.0	Otto	44	-8	23.8	1.67		Berlin	39	-40	2.2	1.15	11.5																		
Cambray				1.55	5.5	Oxford	54	-14	25.2	2.99	19.6	Bottineau	33	-46	-1.1																				
Carlsbad	79	2	42.2	0.35	2.0	Palermo				2.45	14.6	Buxton	37	-30	6.0	0.06	0.6																		
Cloudercroft	43	0	24.2	4.60	46.0	Penn Yan	60	-3	27.3	1.25	6.1	Cando	34	-47	2.0	T.	T.																		
Deming				0.85	3.0	Perry City	56	-12	26.6	2.03	11.1	Churchs Ferry	42	-39	-0.6	0.10	1.0																		
Dorsey	52	-10	23.7	1.04	16.0	Plattsburg	50	0	20.0	1.30	3.0	Coalharbor	36	-40	1.1	0.32	3.2																		
Eagle Rock Ranch	56	-11	24.2	1.04	15.0	Port Jervis	60	-6	28.8	4.37	10.0	Devils Lake	37	-40	-0.2	0.50	5.0																		
Fort Bayard	61	-6	35.6	0.52	7.1	Primrose	62	-3	30.8	4.17	11.5	Donnybrook				0.70	7.0																		
Fort Stanton	57	-9	31.2	0.75	7.5	Redhook				4.54		Dunseith	31	-49	2.3	0.30	3.0																		
Fort Union	60	-21	25.6	1.60	16.0	Richmondville	60	-4	26.0	2.54	11.5	Edgeley	41	-39	6.6	1.34	13.4																		
Fort Wingate	60	0	31.0	0.92	9.2	Ridgeway	54	-4	27.1	2.65	15.8	Elbowoods	37	-46	-1.2	0.50	5.0																		
Fruitland	53	-3	26.8	0.75	7.5	Rome	51	-6	24.3	3.05	20.0	Ellendale	43	-31	6.1	0.70	7.0																		
Gage				0.20	2.0	Romulus	60	-4	28.8	1.26	8.8	Fargo	40	-38	2.5	0.45	4.5																		
Galisteo	52	3	27.4	0.70	7.0	Salisbury Mills				4.87	8.0	Forman	36	-38	4.5	0.71	8.0																		
Gallinas Spring	57	-10	26.0	2.08	29.0	Saranac Lake	56	-16	20.4	2.88	16.2	Fort Yates	46	-30	9.4	T.	T.																		
Hot Springs	56	5	27.9	1.60	16.0	Saratoga Springs	44	-19	25.6	5.12	21.0	Fullerton	37	-37	3.2	1.38	13.8																		
Las Vegas	55	-10	25.6	1.42	15.5	Setauket	59	3	32.8	4.79	10.5	Gallatin				0.06	0.6																		
Lordsburg				T.		Shortsville	63	-3	28.3	1.89	9.4	Glenullin	39	-30	7.7	0.34	3.6																		
Los Lunos	58	0	34.8	0.60	6.0	Skaneateles				2.65		Grafton	42	-39	5.0	0.20	2.0																		
Luna	56	-14	30.8	1.28	10.5	Southampton	53	3	32.6	3.55	8.7	Hamilton	41	-33	3.8	0.26	2.5																		
Mesilla Park	73	9	41.0	0.98		South Butler	59	-4	27.2	2.82	14.2	Hannaford	34	-40	1.9	0.08	0.8																		
Mountainair	55	-12	27.9	5.39	27.0	South Canisteo	56	-10	25.9	2.15	12.5	Jamestown	38	-36	1.4	0.45	4.5																		
Raton	51	-5	23.0	2.10	21.0	Southeast Reservoir				4.96		Larimore	36	-36	3.2	0.10	1.0																		
Roswell	75	-7	37.0	0.96	5.0	South Kortright	58	-18	24.8	3.31	19.3	McKinney	34	-43	1.0	0.60	6.0																		
San Marcial	69	7	39.4	T.	South Schron	53	-19	21.6	4.03	21.8	Mayville	39	-30	6.1	0.16	1.6																			
Strauss				0.60	4.0	Speer Falls	55	-7	25.2	3.85		Medora	42	-44	7.0	0.20	2.0																		
Taos	55	-10	23.4	1.93	14.0	Strait Corners	58	-14	27.8	1.40	8.0	Melville	35	-35	3.4	T.	T.																		
Windsor	50	-18	21.2	1.70	19.5	Ticonderoga	56	-13	25.0	3.17	26.5	Milton	33	-40	-0.4	0.20	2.0																		
New York.						Volusia	52	-8	24.6	2.06		Minnewaukon	34	-39	2.2	T.	T.																		
Adams				3.13	36.0	Walton	58	-11	25.8	2.94	16.9	Minot	36	-34	5.2	T.	T.																		
Addison	61	-11	28.6	1.81	11.0	Wappinger Falls	60	-3	30.0	6.08	13.0	Minto	41	-32	3.6																				
Adirondack Lodge	50	-15	19.9	3.52	25.1	Warwick				3.09		Napoleon	37	-38	3.7	0.15	1.5																		
Akron				2.44		Watertown	55	-15	24.9	3.15	23.2	New England	39	-42	6.6	0.50	5.0																		
Alden	62	-6	27.7	2.71	15.6	Waverly	60	-11	28.2	2.23	12.0	Oakdale	42	-32	11.2	0.60	6.0																		
Amsterdam				2.59	13.0	Westwood	56	-10	25.6	2.25	17.0	Pembina	41	-39	1.7	0.16	1.6																		
Angelica	57	-9	27.0	1.45	6.0	West Bernie	65	-13	25.4	1.90	10.0	Portal	34	-41	-0.9	0.50	5.0																		
Appleton	58	-2	28.3	2.14	T.	Westfield b	56	-6	26.6	3.33		Power	40	-35	5.0	0.92	9.2																		
Arcade	54	-7	24.2	2.42	15.9	Westfield c				2.58	T.	Steele	35	-41	0.8	0.30	3.0																		
Athens	60	-6	27.8	3.56	14.7	Windham	63	-16	26.4	3.16	16.7	University	44	-32	5.6	0.10	1.0																		
Atlanta	50	-8	26.0	2.46	12.0	Youngstown				2.20	8.8	Valley City	38	-39	3.1	0.22	2.2																		
Auburn	62	-4	28.3	1.44	12.0	North Carolina.						Wahpeton	40	-34	5.3	0.60	6.0																		
Avon	56	-7	27.6	1.57	2.4	Biltmore	68	6	40.9	6.83	T.	Willow City	32	-46	-1.4																				
Axton	52	-22	18.1	3.00	20.5	Brevard	65	5	38.2	9.10		Ohio.																							
Baldwinsville	61	-2	27.6	3.07	13.5	Brewers	73	6	41.8	7.67		Akron	61	-8	28.8	3.81	7.3																		
Bedford	60	-3	30.4	5.60		Bryson City				10.92	T.	Atwater				4.01	8.0																		
Blue Mountain Lake				2.95	16.5	Chapelhill	73	15	42.3	5.52		Bangorville	61	-11	28.6	4.35	6.0																		
Bolivar	55	-10	26.4	3.14	15.0	Carrutuck				2.56		Bellefontaine	58	-10	28.9	4.25	9.3																		
Bonville	54	-11	24.1	3.03	20.0	Edenton	70	13	46.7	3.91		Bement				3.21	2.5																		
Boysd Corner				5.70		Fayetteville	73	19	48.8	5.83		Benton Ridge	58	-7	28.4	5.18	9.5																		
Brockport	55	-6	27.2	2.48	16.0	Goldsboro	71	20	47.2	5.76		Bladensburg	64	-11	29.4	4.89	6.2																		
Caldwell	53	-19	22.7	4.90	20.0	Graham				6.26		Blaine				5.54	14.0																		
Canajoharie	58	-8	24.2	2.76	13.7	Greensboro	68	14	43.2	6.62		Bloomington				4.16																			
Canan Four Corner	58	-8	26.2	2.61	13.0	Henderson	70	15	45.2	5.60		Bowling Green	56	-8	26.2	4.19	5.0																		
Carmel	56	-8	28.8	5.55	9.0	Hendersonville	71	6	42.8	10.00		Bucyrus	58	-11	29.8	2.45	8.0																		
Carvers Falls	52	-17	22.5	3.69	11.0	Henrietta	70	15	44.9	10.04		Cambridge	65	-13	32.0	5.45	9.0																		
Cedarhill	62	-8	26.6	2.50	17.5	Highlands	64	-2	33.9	15.93		Camp Dennison	65	-12	32.8	6.38	7.8																		
Chazy	53	-13	21.																																

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Ohio—Cont'd.					
Gallagher	62	-13	28.6	1.01	11.0
Garrettsville	63	-8	30.0	5.27	8.5
Granville	63	-12	30.0	6.21	7.2
Gratiot	62	-9	35.2	7.73	4.0
Green	64	-5	32.9	6.08	7.0
Greenfield	61	-14	27.9	4.00	6.4
Greenhill	58	-9	29.8	4.52	6.0
Greenville	69	-1	36.6	6.45	8.0
Hanging Rock	54	-11	27.2	4.14	3.5
Hedges	60	-12	24.7	3.99	8.0
Hillhouse	60	-13	27.3	4.21	9.0
Hiram	54	-15	26.6	4.00	12.0
Hudson	56	-9	29.4	6.58	9.0
Jacksonboro	59	-10	26.5	3.95	5.5
Kenton	62	-8	29.8	4.76	8.2
Killbuck	65	-7	31.8	7.06	8.0
Lancaster	58	-8	29.2	4.88	8.0
Lima	66	-7	33.1	4.60	7.0
McConnelsville				7.12	8.0
McCormick	62	-5	30.8	6.31	3.0
Manara				3.90	9.0
Mansfield	61	-1	34.2	7.17	6.5
Marietta	63	-10	29.8	3.78	9.3
Marion	62	-12	28.2	4.11	6.0
Medina	62	-9	27.5	6.07	9.0
Milfordton	65	-20	31.1	5.42	8.0
Milligan	61	-18	27.4	4.22	8.2
Millport	49	-10	24.9	3.11	15.5
Montpelier	62	-8	31.0	7.50	14.0
New Alexandria	63	-12	29.0	3.02	7.0
New Berlin	59	-10	30.0	4.08	9.0
New Bremen				5.38	6.5
New Lexington	65	-6	34.6	5.20	7.3
New Richmond	60	-8	29.2	5.42	14.0
New Waterford	62	-9	28.8	4.15	3.0
North Lewisburg	60	-9	27.6	4.33	13.0
North Royalton	60	-8	28.4	5.32	17.5
Norwalk	62	-8	29.3	4.38	5.2
Oberlin	63	-4	29.8	4.87	7.2
Ohio State University	62	-14	27.7	3.22	8.0
Orangeville	58	-7	27.9	4.35	
Ottawa	63	-6	29.8	5.89	7.7
Pataskala	65	-6	32.2	7.13	9.0
Philo	61	-8	30.0	4.40	6.0
Plattsburg	67	-2	32.8	6.27	7.5
Pomeroy				7.45	5.0
Portsmouth a	68	-3	36.7	7.31	4.5
Portsmouth b				6.39	10.0
Pulse				3.58	
Redlion				4.57	6.0
Richfield	63	-12	29.6	4.20	8.2
Richwood	65	-10	32.9	7.25	6.7
Ripley	64	-12	28.8	6.90	6.7
Rittman	58	-9	27.8	4.43	5.0
Rockyridge	60	-9	28.2	3.36	5.0
Shenandoah	60	-9	29.8	4.45	7.7
Sidney	62	-8	34.1	3.42	13.8
Somerset				4.47	
Springfield				5.13	5.0
Swanton	69	-11	34.8	6.59	15.0
Thurman	58	-6	28.6	4.93	9.0
Upper Sandusky	60	-10	29.2	4.20	12.0
Urbana	58	-11	26.9	3.54	5.2
Vickery	59	-8	27.6	4.19	5.2
Wadsworth				3.36	
Walnut				5.60	5.4
Warren	67	-10	30.6	4.51	16.6
Warsaw	65	-16	29.2	5.13	
Wauseon	54	-11	26.3	4.76	14.2
Waverly	69	-13	33.4	7.75	9.6
Waynesville	64	-7	30.8	4.93	4.5
Wellington	67	-6	29.6	3.87	8.0
Willoughby				3.29	
Wooster	63	-9	29.0	3.69	9.2
Zanesville				5.82	8.1
Oklahoma.					
Blackburn	70	-9	34.0	4.77	4.7
Burnett	71	-2	36.9	2.52	0.5
Chandler	68	0	35.0	3.16	3.0
Cleo	71	-2	34.5	3.61	16.5
Clifton	68	-1	36.0	2.86	1.0
Cloud Chief	74	-3	35.1	3.84	6.4
Enid	70	-1	33.6	2.96	9.0
Fort Reno	68	-2	34.6	5.95	31.0
Fort Sill	70	-7	36.9	4.65	0.5
Guthrie	63	-3	33.9	3.35	4.0
Hennessey	73	-1	33.0	4.48	13.0
Jefferson	73	-3	32.0	2.03	1.0
Jenkins	75	-4	32.2	2.81	13.5
Kenton	63	-17	26.4	3.40	46.0
Kingsfisher	64	-3	35.2	4.05	10.8
Mangum	75	-12	37.1	3.25	0.5
Newkirk	65	-1	33.0	0.56	1.4
Norman	72	-4	37.4	2.55	1.5
Pawhuska	68	-10	33.0	4.35	11.0
Perry	68	-1	33.5	3.50	3.2
Sac and Fox Agency	63	-1	37.3	3.32	4.0
Oklahoma—Cont'd.					
Shawnee	68	-5	37.4	3.13	2.0
Stillwater	70	-3	35.2	2.19	1.5
Taloga	74	-4	31.9	2.93	6.0
Temple	70	-9	38.0	4.86	3.0
Ural	74	-0	32.2	3.39	3.3
Weatherford	74	-2	34.4	2.97	4.5
Waukomis	73	-2	34.8	2.77	1.5
Oregon.					
Albany b				1.92	
Alpha	64	-21	40.5	3.91	
Arlington	55	-17	33.8	0.00	
Ashland	60	-12	36.5	0.65	
Astoria	57	-27	41.2	3.18	0.5
Aurora (near)	60	-20	39.3	1.54	T.
Bay City	64	-23	41.0	4.89	4.0
Bend	56	-10	27.2	0.35	0.8
Beulah	49	-16	19.6	0.20	3.0
Blackbutte	53	-17	35.9	1.60	2.0
Blackfoot	60	-20	37.0	0.08	0.5
Bullrun				2.88	
Cascade Locks	56	-18	36.6	2.47	8.0
Coquille				2.91	0.5
Corvallis	60	-21	38.4	1.64	
Dayville	60	-9	33.2	0.64	5.8
Doraville	55	-19	36.4	2.27	0.7
Drain	70	-22	42.2	2.11	0.5
Ella				0.10	
Eugene	55	-22	37.6	1.47	0.2
Fairview	66	-20	41.3	3.20	
Falls City	57	-20	36.7	4.58	0.3
Forest Grove	59	-19	38.6	2.37	
Gardiner	71	-25	45.4	3.28	
Glenora	57	-17	34.0	8.50	1.0
Grants Pass	64	-11	38.5	1.84	
Grass Valley	56	-11	32.0	T.	
Heppner	60	-12	35.0	0.05	0.5
Hood River (near)	59	-13	34.9	1.83	5.0
Huntington	54	-3	24.4	0.27	4.0
Jacksonville	67	-15	37.3	1.69	1.0
Joseph	43	-5	20.8	0.30	3.0
Kerby	64	-13	36.6	3.99	
Klamath Falls	55	-6	26.8	T.	
Lagrange	47	-2	27.2	0.16	0.8
Lakeview	44	-9	21.9	1.14	6.8
Lone Rock	62	-3	30.6	4.00	6.0
McKenzie Bridge	61	-7	34.3	3.95	3.0
McMinnville	59	-20	39.4	1.87	0.2
Monroe	59	-20	38.8	2.67	T.
Mount Angel	59	-23	39.0	1.46	T.
Nehalem				4.70	
Newport	63	-24	43.4	2.85	T.
Pendleton	61	-0	33.6	0.02	
Pine	46	-24	15.8	0.47	5.0
Placer				2.24	12.0
Prineville				0.39	2.0
Riverside				0.50	5.0
Salem b	60	-23	39.9	0.88	
Silverlake	52	-21	24.5	0.55	5.5
Sparta	42	-3	19.9	0.50	5.0
Stafford	59	-20	39.2	1.79	
The Dalles	58	-18	36.0	0.47	2.0
Toledo	70	-22	44.2	3.70	T.
Umatilla	60	-14	35.0	0.02	
Vale	54	-10	21.2	0.23	2.0
Wamic	56	-3	31.4	0.90	1.0
Warm Spring	57	-11	33.6	0.27	6.0
Weston	51	-3	29.3	0.68	
Williams	62	-11	37.1	1.17	2.5
Pennsylvania.					
Aleppo	62	-9	32.6	5.23	12.0
Altoona	64	-7	30.0	4.59	
Athens	64	-13	27.4	2.54	17.8
Beaver Dam				3.45	7.0
Bellefonte	58	-5	32.6	4.23	10.2
Brookville				4.24	10.4
Browsers				5.77	
Butler	59	-9	29.6	3.54	8.3
California	68	-5	34.9	4.95	7.8
Cassandra	58	-8	28.2	4.42	19.0
Centerhall	57	-8	29.6	3.21	9.5
Clarion				3.96	13.0
Coatesville	68	-7	33.5	5.29	10.3
Confluence				1.98	3.4
Davis Island Dam				3.75	4.0
Derry Station	62	-6	31.5	4.86	11.5
Doylestown				6.12	
Driftwood				2.72	8.0
Dushore	57	-15	25.6	4.02	16.6
Dyberry	55	-13	24.9	4.75	14.5
East Bloomsburg				3.63	11.0
East Mauch Chunk	60	-13	29.8	5.93	10.0
Easton	65	-2	31.5	4.23	7.0
Ellwood Junction				3.54	6.0
Emporium	56	-10	27.8	5.21	13.5
Ephrata	65	-5	32.6	4.93	9.0
Everett	57	-6	29.6	5.00	7.0
Forks of Nesquehanna				4.65	
Franklin	60	-10	28.8	4.33	7.0
Pennsylvania—Cont'd.					
Freeport	66	-4	30.6	4.75	7.9
Girardville				5.86	16.5
Grampian	56	-10	27.6	4.64	16.0
Greensboro				5.31	6.0
Greenville	61	-12	28.2	5.42	16.0
Hamburg	62	-1	32.4	5.77	2.0
Hamlington	59	-8	26.9	2.99	13.8
Harris Island Dam				3.71	5.5
Huntingdon a				4.98	
Huntingdon b	61	-6	32.2	5.38	7.0
Indiana	60	-9	30.6	3.55	
Johnstown	63	-3	32.4	5.80	11.6
Keating				3.79	5.0
Kennett Square	67	-4	34.0	5.21	10.0
Lansdale				4.80	
Lawrenceville	61	-17	26.6	2.33	17.0
Lebanon	68	-4	32.4	5.95	10.0
Leroy	56	-12	27.0	3.00	16.0
Lewisburg	58	-7	29.9	4.85	13.5
Lockhaven a	59	-5	31.6	2.99	11.5
Lockhaven b				3.40	6.0
Lock No. 4				4.49	11.1
Lycippus	60	-6	31.8	4.30	16.5
Mifflin				4.45	9.0
Milford	60	-12	28.6	5.41	10.0
Oil City				5.07	10.7
Ottsville				5.11	
Parker				5.16	11.2
Philadelphia	67	-4	37.1	4.58	7.0
Pocono Lake	57	-12	25.6	3.97	10.0
Point Pleasant				5.03	
Pottsville				5.52	
Quakertown	66	-6	32.2	5.08	9.0
Reading	65	-3	32.3	5.59	
Renovo a	62	-4	30.0	3.89	10.5
Renovo b				3.60	
Saegertown	58	-13	27.4	4.58	5.0
St. Marys	51	-10	26.6	3.50	5.0
Saltsburg				4.04	10.0
Seisholtzville				5.56	
Selinsgrove	61	-7	31.4	4.84	12.0

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.		Stations.	Temperature. (Fahrenheit.)			Precipitation.		Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.		Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.		Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
South Carolina—Cont'd.						Tennessee—Cont'd.						Texas—Cont'd.					
Pinopolis *.	74	26	52.0	5.64		Isabella	72	7	40.8	11.41	0.5	Lampasas	77	14	45.4	6.20	1.5
St. Stephens				4.64		Jackson	70	-4	41.0	5.38	5.0	Lapara				3.29	1.0
Saluda	75	14	47.4	9.23		Johnsonville	71	-1	40.8	5.97	2.8	Laureles Ranch				7.12	
Santuck	71	17	45.6	7.75	T.	Jonesboro	73	6	41.4	6.68	1.2	Llano	80	19	45.0	6.40	1.0
Selvern	81	18	48.0	7.25		Kenton	74	-1	40.2	8.34	3.0	Longview	73	12	47.0	9.34	0.4
Smiths Mills				3.53		Kingston				10.69	1.0	Luling	76	18	49.0	8.86	
Society Hill	72	22	49.4	8.24		Leadville				6.40	T.	Mann	82	13	45.8	8.72	1.0
Spartanburg	70	14	44.5	9.03		Lewisburg	69	0	43.2	7.73	3.8	Marlin	79	18	45.2	7.64	
Statesburg	77	20	51.6	7.28		Liberty	75			7.85	0.3	Menardville	77	12	42.4	3.83	1.0
Summerville	77	22	52.4	4.31		Lynchville	66	1	41.5	8.41	3.0	Mount Blanco	71	6	35.3	0.33	3.0
Sumter	74	22	49.8	4.65		McKenzie	72	-4	40.2	9.80	2.5	Nacogdoches	74	13	48.6	6.70	T.
Temperance	73	24	48.8	5.66		McMinnville	72	0	42.8	8.48	2.6	New Braunfels				9.87	
Trenton	75	18	49.9	9.66		Maryville	74	9	43.3	9.93	2.0	Panther				4.42	2.0
Trial	77	22	52.1	5.57		Newport	76	10	42.6	7.32	1.0	Paris	78	-2	43.0	5.80	6.0
Walhalla	68	12	44.8	7.20		Nunnally	69	1	40.6	5.98	1.0	Pearsall	77	23	52.8	5.75	
Wainsboro	73	18	45.7	8.50		Oakhill	70	-6	42.0	7.20	5.0	Rhineland	72	5	38.3	3.73	2.0
Winthrop College	70	16	47.2	7.61		Palmetto	68	0	42.6	7.25	4.0	Rockisland	77	20	52.4	7.74	T.
Yorkville	72	18	48.4	6.86		Pope	70	5	41.4	6.47	3.0	Rockport	72	30	56.2	5.36	
South Dakota.						Rogersville	73	7	41.6	7.34	1.0	Runge	78	20	52.8	9.48	
Aberdeen	44	-39	6.2	1.80	9.0	Rugby	69	-11	38.8	9.48	8.0	Sanderson	75	16	46.0	1.50	1.0
Academy	45	-22	14.6	0.75	7.2	Savannah	70	2	43.5	7.08	3.0	San Marcos	76	17	49.4	10.31	
Alexandria	46	-24	10.0	0.95	8.0	Sewanee	64	1	40.6	12.97	3.0	San Saba	78	11	45.4	3.88	0.9
Armour	45	-24	11.6	1.25	12.5	Silverlake	71	0	38.6	7.21	2.2	Santa Gertrude Ranch				5.55	
Ashecroft	54	-37	15.9	0.40	4.0	Springdale	71	4	41.8	9.34	2.0	Shaeffer Ranch	81	20	55.7	8.16	
Bowdle	43	-30	7.6	0.25	2.5	Springville	74	-7	40.6	8.97	6.0	Sherman	69	13	42.8	5.39	4.3
Brookings	41	-26	10.7	0.28	3.0	Tazewell				8.43	1.2	Sonora	75	15	44.8	2.75	1.0
Canton	45	-20	16.2	0.34	3.8	Tellico Plains	71	10	45.2	9.90	1.5	Sugarland	79	18	52.6	6.83	
Cavite	47	-22	14.9			Tracy City	69	-2	41.2	11.30	3.5	Sulphur Springs	82	8	45.4	7.55	2.0
Centerville				1.52	9.8	Trenton	74	-1	41.2	8.76	6.0	Temple	77	15	43.2	8.07	
Chamberlain	46	-22	14.6	0.77	10.7	Tullahoma	68	0	43.5	9.92	1.0	Trinity	77	14	50.1	7.24	
Cherry Creek	55	-26	16.8	0.05		Union City	71	-4	39.0	7.74	5.0	Tulia	69	0	30.8	1.60	16.0
Clark	40			0.30	3.0	Waynesboro	69	1	42.2	6.09	4.0	Tyler	76	12	45.8	6.78	2.0
Doland	40	-31	7.3	0.43	4.5	Wildersville	69	0	41.8	7.39	4.0	Victoria	84	20	53.6	6.15	
Elkpoint	48	-20	16.5	2.07	11.2	Yukon	68	2	43.5	10.42	3.0	Waco	76	20	50.8	6.19	1.0
Farmingdale				0.24	2.3	Texas.						Waxahachie				5.47	3.0
Faulkton	40	-29	8.6	0.63	6.3	Albany	74	12	40.7	5.46		Weatherford	74	9	42.6	3.66	2.0
Flandreau	41	-22	13.0	0.32	2.8	Alvin				7.53		Wharton	75	20	58.3	8.50	
Forestburg	40	-30	8.0	0.53	5.3	Arthur				6.54	4.0	Wichita Falls				6.80	6.0
Fort Meade	50	-20	17.9	0.90		Austin	76	17	51.6	9.41		Utah.					
Gannaville	41	-26	11.0	1.35	13.5	Austin *	72	12	45.3			Alpine	52	2	27.2	0.50	4.5
Gettysburg	42	-28	10.4	0.25	2.5	Balling	74	12	42.6	3.67		Aneth	47	-24	11.2	1.30	13.0
Grand River School	52	-28	12.4	0.01	0.2	Beaumont	78	20	54.5	8.78		Blackrock	47	-		0.02	0.2
Greenwood	45	-17	17.0	1.07	9.7	Beville	81	22	54.0	7.14		Bluecreek *	47	-11	23.6	0.02	0.2
Highmore				0.30	3.0	Big Spring	72	6	40.8	0.86	2.5	Castledale	50	23	14.0	0.28	2.8
Hot City	43	-27	11.2	0.39	7.0	Blanco	74	14	45.4	7.39	T.	Cisco	38	-22	13.1	1.35	13.5
Howard	43	-22	14.4	0.20	2.0	Bonham	72	12	47.3	8.70		Corinne	42	-14	16.7	0.10	1.0
Howell	41	-28	8.6	0.58	5.4	Booth	72	6	43.1	6.05	4.5	Coyote	48	-24	14.0	0.03	0.3
Ipswich	40	-31	6.3	0.88	4.0	Bowie				6.62		Deseret	42	-28	10.2	1.30	13.0
Kimball	40	-25	11.6	0.40	4.0	Brazoria	73	5	40.1	5.07	8.0	Emery	46	-11	19.2	0.40	4.0
Leola	40	-36	5.3	0.60	6.0	Brenham	77	20	56.0	7.09		Escalante	52	-11	20.2	0.50	5.0
Marion	43	-20	14.6	1.01		Brighton	78	18	50.2	6.69	0.5	Farmington	40	-9	19.1	0.86	8.6
Mellette	42	-30	7.4	0.40	4.0	Brownwood	74	22	56.7	5.52		Fillmore	53	-14	19.6	1.26	
Menno	45	-21	13.2	0.71	7.0	Burnet	75	21	49.2	3.10	1.0	Fort Duchesne	34	-35	1.6	0.80	8.0
Millbank	41	-25	10.6	0.30		Camp Eagle Pass	76	28	54.4	7.08		Frisco	51	-6	20.9	1.66	
Mitchell	40	-24	11.0	0.70	7.0	Childress	75	9	37.1	3.37	1.0	Garrison	47	-18	16.8	0.60	10.0
Oelrichs	41	-22	15.5	0.65	6.5	Coleman	80	12	42.4	3.56		Giles	42	-18	12.9	0.42	4.8
Pedro	54	-21	16.0	0.10	1.0	College Station	80	17	49.7	5.54	T.	Government Creek	46	-15	16.0	1.10	11.0
Pine Ridge	40	-20	15.6	0.19	2.0	Colorado	75	2	40.4	1.00		Green River	50	-23	13.9	0.55	5.5
Plankinton		-23		0.39	3.9	Columbia	77	20	55.2	7.32		Grover	55	-5	24.0	0.40	4.0
Ramsey	43	-25	11.0	0.25	2.5	Comanche	77	10	43.0	3.93	2.0	Heber	40	-30	10.7	0.70	
Redfield	40	-30	6.9	0.83	6.0	Corsicana	84	20	51.5	6.91	2.0	Henefer	47	-39	9.0	1.23	13.6
Rosebud	49	-20	18.2	0.50	4.7	Cotulla				5.50		Hite	58	11	32.4	0.24	3.0
Silver City				0.60	6.0	Cuero	78	22	53.4	9.05	T.	Huntsville				0.61	6.5
Sioux Falls	45	-21	12.4	0.47		Dallas	80	12	42.6	7.16	6.0	Ibapah	45	-32	14.8	0.88	8.8
Sioux Agency	40	-30	9.9	0.24	2.4	Danevang	80	19	53.2	6.59		Kanab	52	0	27.2	1.24	8.0
Spearfish	48	-15	17.6	0.85	8.5	Dubin	78	11	42.2	3.60	2.0	Kelton				0.30	3.0
Tyndall	46	-21	13.8	1.10	11.0	Duval	74	15	48.2	7.12		La Sal	44	-12	17.2	0.90	9.0
Vermillion	49	-22	16.0	1.06	15.0	Estelle	76	10	43.4	5.59	9.0	Levan	45	-15	14.0	0.98	9.8
Watertown	39	-30	8.4	0.12	1.2	Fort Brown	82	26	61.6	1.72		Lea	39	-35	7.2	0.00	
Waubay	40	-35	4.9	0.15	1.5	Fort Clark	72	15	46.7	1.70		Logan	39	-17	13.3	0.33	
Wentworth	41	-24	10.8	0.43	4.3	Fort Davis	72	4	42.4	0.50	5.0	Lund	43	-30	12.1		

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Temperature. (Fahrenheit.)						Precipitation.		Temperature. (Fahrenheit.)						Precipitation.		Temperature. (Fahrenheit.)						Precipitation.							
Maximum.		Minimum.		Mean.		Rain and melted snow.		Total depth of snow.		Maximum.		Minimum.		Mean.		Rain and melted snow.		Total depth of snow.		Maximum.		Minimum.		Mean.		Rain and melted snow.		Total depth of snow.	
Stations.						Stations.						Stations.						Stations.											
Utah—Cont'd.						Washington—Cont'd.						Wisconsin—Cont'd.																	
Woodruff	42	-36	2.6	0.05	0.5	Port Townsend	56	27	39.7	1.14	0.1	Fond du Lac	48	-16	21.8	0.52													
Vermont.						Pullman	49	6	29.5	T.	T.	Grand Rapids	46	-23	16.0														
Bellows Falls				3.67	15.5	Rattlesnake Mountains	47	5	27.2	0.64	6.5	Grand River Locks				0.81	9.5												
Burlington	55	-4	24.8	1.92	16.0	Republic	47	-8	21.8	0.45	5.0	Grantsburg	42	-40	11.0	1.90	11.0												
Chelsea	50	-16	20.0	2.73	21.0	Ritzville				0.69	6.5	Hancock	45	-21	16.4	1.41	10.0												
Cornwall	55	-11	23.8	2.73	17.0	Rosalia	50	-1	28.2	0.12	0.5	Harvey	51	-13	21.6	1.20	6.4												
Enosburg Falls	56	-20	19.0	4.64	32.5	Sedro-Woolley	61	21	38.4	0.96	T.	Hayward	43	-35	11.4	1.22	13.7												
Jacksonville	52	-18	20.3	4.23	22.0	Silvana	58	19	36.9	1.75		Hillsboro	49	-21	16.7	1.55	12.0												
Manchester	56	-6	25.0	3.10	15.0	Snohomish	59	17	36.5	1.89	T.	Koepnick	50	-30	14.3	0.84	8.0												
Morrisville	57	-26	19.8	5.24	34.4	Snoqualmie	55	19	36.3	4.50		Ladysmith	50	-27	14.1	0.32	3.2												
Norwich	54	-22	20.7	3.78	20.0	Southbend	60	24	40.9	6.78		Lancaster	47	-18	18.4	0.45	9.5												
St. Johnsbury	49	-29	20.5	2.25	20.5	Sprague	63	-2	31.0	0.41	4.0	Madison	47	-15	20.3	1.11	6.5												
Wells	58	-12	23.9	3.43	14.0	Sunnyside	52	5	26.9	0.34	3.0	Manitowoc	46	-13	21.4	1.10	10.1												
Wells River				3.49	19.0	Trinidad	60	22	36.8	5.01	1.6	Meadow Valley	50	-22	15.4	0.62	5.5												
White River Junction				2.91	18.2	Union	46	-13	20.2	0.64	4.0	Medford	49	-27	14.0	0.20	2.0												
Woodstock	50	-20	22.4	3.59	27.0	Usk	46	-13	20.2	0.64	4.0	Menasha				0.60	6.0												
Virginia.						Vancouver	60	19	40.0	1.84	0.3	Neillsville	46	-26	11.5	1.37	8.0												
Alexandria	70	5	37.8	4.95	2.0	Vashon	56	23	39.0	1.76	T.	New London	44	-21	17.6	1.09	7.5												
Ashland	73	8	40.8	4.76	1.0	Waterville	45	-5	21.6	0.27	2.0	North Crandon	44	-25	13.4	0.15													
Barboursville	74	2	40.4	5.65	3.0	Wenatchee (near)	50	4	27.6	0.72	4.0	Oconto	45	-16	19.4	1.83	12.5												
Bedford	70	6	41.9	5.48	2.0	Whitcom	60	20	38.6	1.44	0.5	Oscola	42	-25	13.4	0.44	6.5												
Bigstone Gap	65	-3	40.5	8.72	4.0	Wilbur	47	-7	22.4	0.50	5.0	Oshkosh	46	-18	20.4	0.79	10.2												
Blacksburg	65	-1	35.2	5.61	3.2	Zindel	54	10	32.8	0.13	T.	Pine River	46	-21	18.6	1.07	10.5												
Bonair	73	5	41.8	4.53	0.2	West Virginia.						Portage	49	-17	21.6	0.92	12.0												
Boykins				4.00		Bayard	61	-8	29.2	6.10	4.0	Port Washington	54	-13	23.0	2.10	14.0												
Bristol	69	3	38.2	6.32	T.	Beverly	62	-4	32.4	6.18	18.0	Prairie du Chien a	57	-15	23.2	1.33	7.5												
Buckingham	71	10	40.1	3.98	T.	Bluefield	65	-2	41.4	4.45	3.0	Prairie du Chien b	43	-29	13.4	0.60	4.5												
Burkes Garden	62	-6	35.2	6.75	1.0	Buckhannon	65	-11	33.4	6.43	11.0	Prentice	43	-12	24.0	0.77	14.2												
Callville	70	12	41.7	5.12		Burlington	67	-4	32.2	3.42	8.0	Racine	43	-12	24.0	0.77	14.2												
Charlottesville	76	2	40.2	4.40	2.0	Byrne	68	-17	36.0	6.25	12.0	Sheboygan	46	-13	23.6	1.36	8.0												
Clarksville				5.74		Camden	62	-14	35.0	6.37	12.4	Spooner	41	-33	10.4	1.92	19.6												
Columbia	73	3	37.4	4.00	5.0	Central	67	-16	32.7	6.48	7.0	Stevens Point	47	-24	15.4	1.79	13.6												
Dale Enterprise	71	-9	36.2	3.42	7.0	Chapel	64	-16	36.8	9.59	8.4	Tomahawk	46	-30	11.0	0.26	2.6												
Danville				5.62		Charleston a	71	-11	41.6	.....	.....	Valley Junction	52	-20	18.7	0.85	8.0										
Farmville	70	13	42.2	4.70	T.	Charleston b				6.36	9.0	Viroqua	45	-20	17.8	1.09	10.6												
Hampton	69	13	44.2	3.64	T.	Clay	72	-10	40.0	8.72	12.0	Watertown	50	-15	19.6	1.79	10.7												
Hot Springs	60	-6	34.9	5.80	4.0	Creston	62	-8	33.0	4.74	5.0	Waukesha	46	-14	21.6	0.72	5.4												
La Crosse	72	14	42.5	5.50	0.0	Cuba	74	-18	37.6	6.94	11.5	Waupaca	44	-22	16.6	1.02	7.9												
Lexington	74	3	39.8	5.18	3.5	Dayton	65	-18	32.6	6.51	7.5	Wausau	42	-22	15.6	1.05	7.0												
Lincoln	71	-13	35.5	3.95	6.0	Echo	72	-17	37.7	7.00	9.0	Whitehall	55	-23	16.0	1.35	10.9												
Manassas	72	2	37.1	4.24	2.2	Elkhorn	70	-2	40.6	4.88	3.1	Wyoming.																	
Marion	69	2	39.1	7.32	T.	Fairmont				4.94	8.9	Alcoa	46	-18	18.6	0.90	6.0												
Mendota				3.68		Glenville	68	-13	33.6	6.39	13.0	Basin	48	-17	15.9	0.21	2.1												
Newport News	76	13	45.2	5.52	T.	Grafton	65	-7	33.3	5.65	9.8	Bedford	34	-34	7.3	0.20	2.0												
Petersburg	72	10	42.2	3.90	T.	Green Sulphur	66	-7	33.8	4.74	4.0	Border	39	-51	-2.8	0.50	.....											
Radford				1.98	0.9	Harpers Ferry				3.45	8.0	Buffalo	49	-24	16.1	0.41	4.8												
Riverton				5.21	0.1	Highland Springs	60	-6	30.0	5.33	15.5	Centennial	36	-34	11.4	0.86	8.6												
Roanoke	60	7	38.1	5.21	0.1	Hinton	66	-3	38.7	5.56	3.8	Chugwater	47	-28	17.8	1.25	12.5												
Rockymount	63	7	38.8	5.84	.....	Huntington	68	-4	35.0	6.65	7.0	Daniel	35	-49	9.6	0.45	4.5											
Saxe	73	11	42.2	5.67	T.	Leonard	61	-9	33.8	8.17	9.0	Evanston	40	-34	9.1	0.80	6.7												
Shenandoah				2.79	7.3	Lewisburg	64	-4	34.8	5.86	5.0	Fort Laramie	52	-26	18.4	0.76	12.0												
Speers Ferry				8.18		Lillydale	66	-3	38.6	4.94	1.7	Fort Washakie	51	-28	18.5	0.13	1.3												
Spottsville	74	12	43.7	4.19	T.	Logan	71	-6	41.8	8.70	9.0	Fort Yellowstone	40																

TABLE II.—Climatological record of voluntary and other cooperating observers—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
<i>Porto Rico—Cont'd.</i>	°	°	°	<i>Ins.</i>	<i>Ins.</i>
Ponce.....	88	59	76.2		
Rio Piedras.....				1.54	
San German.....	89	63	76.6	1.45	
San Lorenzo.....	86	55	72.1	2.46	
San Salvador.....	86	58	71.6	0.75	
Santa Isabel.....	88	62	75.5	0.41	
Utua.....	88	57	72.2	0.20	
Vieques.....	86	68	77.6	1.77	
Yauco.....	86	59	74.3	0.33	
<i>Mexico.</i>					
Ciudad P. Diaz.....	80	23	52.9	2.42	
Leon de Aldamas.....	79	38	56.4	0.03	
Vera Cruz.....	85	62	72.6		
<i>New Brunswick.</i>					
St. John.....	48	- 4	22.2	4.38	11.6
<i>Isthmus of Panama.</i>					
Bohio.....				0.24	
Colon.....				0.28	
Gamboa.....				0.12	
La Boca.....	88	74	80.4	0.00	
<i>Late reports for January, 1903.</i>					
<i>Alaska.</i>					
Coal Harbor.....	40	-10	23.2	3.90	28.0
Juneau.....		- 5		11.31	
Kenai.....	49	-36	5.0	0.83	9.5
Wood Island.....	42	4	23.2	4.74	10.8
<i>California.</i>	°	°	°	<i>Ins.</i>	<i>Ins.</i>
Le Grand.....	65	26	44.6	2.39	
San Miguel Island.....	74	43	55.2	0.65	
<i>Connecticut.</i>					
Wallingford.....				4.01	6.8
West Cornwall.....	47	- 6	23.0	3.93	9.8
<i>Idaho.</i>					
Ola.....				6.45 ¹	
<i>Missouri.</i>					
Oregon.....	53	- 2	29.4	0.23	2.0
<i>Nebraska.</i>					
Tecumseh.....				0.11	T.
Wallace.....				0.20	2.0
Wisner.....				0.00	
<i>North Dakota.</i>					
Minto.....	35	-29	6.2		
<i>Ohio.</i>					
Cleveland.....	59	- 4	26.0	1.45	10.8
Kenton.....	54	- 8	24.9	2.51	11.6
<i>Texas.</i>					
Anson.....				1.30	
Tulia.....	77	9	38.9	0.40	4.0
<i>Wyoming.</i>					
Kimball Ranch.....	58	1	33.6	0.33	3.3
<i>Porto Rico.</i>					
Corozal.....	91	52	73.7	0.35	
Isabela.....	85	62	74.0	1.01	
Ponce.....	87	60	76.0	0.42	
San Lorenzo.....	86	56	72.6	2.18	
Utua.....	88	59	73.0	T.	

EXPLANATION OF SIGNS.

*Extremes of temperature from observed readings of dry thermometer.

A numeral following the name of a station indicates the hours of observation from which the mean temperature was obtained, thus:

¹Mean of 7 a. m. + 2 p. m. + 9 p. m. + 4.

²Mean of 8 a. m. + 8 p. m. + 2.

³Mean of 7 a. m. + 7 p. m. + 2.

⁴Mean of 6 a. m. + 6 p. m. + 2.

⁵Mean of 7 a. m. + 2 p. m. + 2.

⁶Mean of readings at various hours reduced to true daily mean by special tables.

The absence of a numeral indicates that the mean temperature has been obtained from daily readings of the maximum and minimum thermometers.

An italic letter following the name of a station, as "Livingston a," "Livingston b," indicates that two or more observers, as the case may be, are reporting from the same station. A small roman letter following the name of a station, or in figure columns, indicates the number of days missing from the record; for instance "a" denotes 14 days missing.

No note is made of breaks in the continuity of temperature records when the same do not exceed two days. All known breaks, of whatever duration, in the precipitation record receive appropriate notice.

CORRECTIONS.

The following change has been made in name of station: Alabama, Oxanna changed to Anniston.

TABLE III.—Resultant winds from observations at 8 a. m. and 8 p. m., daily, during the month of February, 1903.

Stations.	Component direction from—				Resultant.		Stations.	Component direction from—				Resultant.	
	N.	S.	E.	W.	Direction from—	Duration.		N.	S.	E.	W.	Direction from—	Duration.
<i>New England.</i>							<i>North Dakota.</i>						
Eastport, Me.	17	10	7	33	n. 75 w.	27	Moorhead, Minn.	17	20	8	25	s. 80 w.	17
Portland, Me.	12	18	5	32	s. 78 w.	28	Bismarck, N. Dak.	34	7	7	25	n. 34 w.	32
Concord, N. H.	7	5	7	13	n. 72 w.	6	Williston, N. Dak.	15	23	8	22	s. 60 w.	16
Northfield, Vt.	19	27	2	16	s. 60 w.	16	<i>Upper Mississippi Valley.</i>						
Boston, Mass.	11	10	5	39	n. 88 w.	34	Minneapolis, Minn.*	8	5	2	18	n. 79 w.	16
Nantucket, Mass.	14	16	5	32	s. 86 w.	27	St. Paul, Minn.	15	18	11	27	s. 79 w.	16
Narragansett, R. I.*	9	9	2	18	w.	16	La Crosse, Wis. †	9	12	1	6	s. 59 w.	6
Block Island, R. I.	15	18	6	32	s. 83 w.	26	Davenport, Iowa	15	15	8	29	w.	21
New Haven, Conn.	20	10	4	31	n. 70 w.	29	Des Moines, Iowa	24	13	9	24	n. 54 w.	19
<i>Middle Atlantic States.</i>							Dubuque, Iowa	20	17	7	26	n. 81 w.	19
Albany, N. Y.	18	26	3	20	s. 65 w.	19	Keokuk, Iowa	20	15	11	25	n. 70 w.	15
Binghamton, N. Y.†	7	6	6	13	n. 82 w.	7	Cairo, Ill.	22	18	14	16	n. 27 w.	4
New York, N. Y.	16	10	6	33	n. 78 w.	28	Springfield, Ill.	19	13	15	21	n. 45 w.	8
Harrisburg, Pa.	13	14	14	25	s. 85 w.	11	Hannibal, Mo.†	9	5	4	15	n. 70 w.	12
Philadelphia, Pa.	13	15	6	32	s. 86 w.	27	St. Louis, Mo.	21	17	10	18	n. 63 w.	9
Scranton, Pa.	16	17	12	25	s. 86 w.	13	<i>Missouri Valley.</i>						
Atlantic City, N. J.	19	15	5	30	n. 81 w.	25	Columbia, Mo.*	11	10	6	9	n. 72 w.	3
Cape May, N. J.	17	15	7	27	n. 84 w.	20	Kansas City, Mo.	23	18	13	15	n. 22 w.	5
Baltimore, Md.	13	13	16	25	w.	9	Springfield, Mo.	20	13	18	16	n. 16 e.	7
Washington, D. C.	15	16	10	22	s. 85 w.	12	Topeka, Kans.*	13	5	7	10	n. 21 w.	8
Cape Henry, Va.	7	13	5	10	s. 40 w.	9	Lincoln, Nebr.	29	17	8	13	n. 23 w.	13
Lynchburg, Va.	12	19	11	31	s. 71 w.	21	Omaha, Nebr.	31	16	5	14	n. 31 w.	18
Norfolk, Va.	13	25	18	13	s. 23 e.	16	Valentine, Nebr.	23	11	9	27	n. 56 w.	22
Richmond, Va.	15	23	7	21	s. 60 w.	16	Sioux City, Iowa†	12	11	5	7	n. 63 w.	2
Wytheville, Va.	12	8	10	36	n. 75 w.	27	Pierre, S. Dak.	22	9	27	7	n. 57 e.	24
<i>South Atlantic States.</i>							Huron, S. Dak.	23	15	13	18	n. 32 w.	9
Asheville, N. C.	23	19	11	20	n. 14 w.	4	Yankton, S. Dak.†	6	8	5	15	s. 79 w.	10
Charlotte, N. C.	14	21	17	17	n.	7	<i>Northern Slope.</i>						
Hatteras, N. C.	21	15	16	20	n. 34 w.	7	Havre, Mont.	18	9	15	30	n. 59 w.	18
Kittyhawk, N. C.	10	7	9	10	n. 18 w.	3	Miles City, Mont.	17	19	7	23	s. 83 w.	16
Raleigh, N. C.	20	17	6	28	n. 82 w.	22	Helena, Mont.	16	14	6	31	n. 85 w.	25
Wilmington, N. C.	18	18	14	20	w.	6	Kalispell, Mont.	6	9	3	44	s. 86 w.	41
Charleston, S. C.	19	19	14	18	w.	4	Rapid City, S. Dak.	25	6	12	23	n. 30 w.	22
Columbia, S. C.	15	18	19	18	s. 18 e.	3	Cheyenne, Wyo.	23	18	6	24	n. 74 w.	19
Augusta, Ga.	16	10	17	24	n. 49 w.	9	Lander, Wyo.	15	20	14	17	s. 31 w.	6
Savannah, Ga.	19	15	15	18	n. 37 w.	5	North Platte, Nebr.	18	14	9	26	n. 77 w.	18
Jacksonville, Fla.	26	17	13	12	n. 6 e.	9	<i>Middle Slope.</i>						
<i>Florida Peninsula.</i>							Denver, Colo.	24	18	14	13	n. 9 e.	6
Jupiter, Fla.	16	21	25	9	s. 73 e.	17	Pueblo, Colo.	18	13	25	15	n. 63 e.	11
Key West, Fla.	15	17	35	3	s. 87 e.	32	Concordia, Kans.	23	12	32	18	n. 24 w.	12
Tampa, Fla.	24	13	18	11	n. 32 e.	13	Dodge, Kans.	26	10	17	17	n.	16
<i>Eastern Gulf States.</i>							Wichita, Kans.	24	15	19	12	n. 38 e.	11
Atlanta, Ga.	20	19	14	17	n. 72 w.	3	Oklahoma, Okla.	27	14	13	10	n. 13 e.	13
Macon, Ga.	15	5	4	9	n. 27 w.	11	<i>Southern Slope.</i>						
Pensacola, Fla.†	12	5	13	5	n. 49 e.	11	Abilene, Tex.	19	19	11	19	w.	8
Mobile, Ala.	26	18	13	11	n. 14 e.	8	Amarillo, Tex.	22	18	16	15	n. 14 e.	4
Montgomery, Ala.	16	19	20	13	s. 67 e.	8	<i>Southern Plateau.</i>						
Meridian, Miss.†	9	7	11	6	n. 68 e.	5	El Paso, Tex.	22	3	22	23	n. 3 w.	19
Vicksburg, Miss.	17	17	22	15	e.	12	Santa Fe, N. Mex.	21	19	16	12	n. 63 e.	4
New Orleans, La.	23	16	21	11	n. 55 e.	12	Flagstaff, Ariz.	7	19	24	17	s. 30 e.	14
<i>Western Gulf States.</i>							Phoenix, Ariz.	13	12	21	21	n.	1
Shreveport, La.	19	15	22	12	n. 68 e.	11	Yuma, Ariz.	37	7	9	9	n.	30
Fort Smith, Ark.	15	5	27	17	n. 45 e.	14	Independence, Cal.	32	12	9	15	n. 17 w.	21
Little Rock, Ark.	20	14	17	18	n. 9 w.	6	<i>Middle Plateau.</i>						
Corpus Christi, Tex.	27	11	20	7	n. 39 e.	21	Carson City, Nev.	13	29	7	17	s. 32 w.	19
Fort Worth, Tex.	24	11	16	15	n. 4 e.	13	Winnemucca, Nev.	26	10	25	12	n. 39 e.	21
Galveston, Tex.	16	14	30	8	n. 85 e.	22	Modena, Utah	15	7	20	23	n. 21 w.	8
Palestine, Tex.	24	13	17	16	n. 5 e.	11	Salt Lake City, Utah	14	19	18	20	s. 22 w.	5
San Antonio, Tex.	25	10	22	11	n. 36 e.	19	Grand Junction, Colo.	26	7	15	20	n. 15 w.	20
Taylor, Tex.†	13	8	4	7	n. 31 w.	6	<i>Northern Plateau.</i>						
<i>Ohio Valley and Tennessee.</i>							Baker City, Oreg.	12	30	18	16	s. 6 e.	18
Chattanooga, Tenn.	17	18	14	20	s. 80 w.	6	Boise, Idaho	11	23	12	23	s. 43 w.	16
Knoxville, Tenn.	18	17	12	25	n. 86 w.	13	Lewiston, Idaho†	4	4	19	5	e.	14
Memphis, Tenn.	21	18	17	17	n.	3	Pocatello, Idaho	2	12	34	15	s. 62 e.	22
Nashville, Tenn.	18	20	14	17	s. 56 w.	4	Spokane, Wash.	16	14	23	17	n. 72 e.	6
Lexington, Ky.†	5	12	7	10	s. 23 w.	8	Walla Walla, Wash.	6	36	7	15	s. 15 w.	31
Louisville, Ky.	14	21	12	17	s. 36 w.	9	<i>North Pacific Coast Region.</i>						
Evansville, Ind.†	10	7	7	8	n. 18 w.	3	North Head, Wash.	20	11	25	12	n. 55 e.	16
Indianapolis, Ind.	18	19	11	19	s. 83 w.	8	Port Crescent, Wash.*	4	3	19	6	n. 86 e.	13
Cincinnati, Ohio	16	20	14	23	s. 66 w.	10	Seattle, Wash.	23	11	21	13	n. 34 e.	14
Columbus, Ohio	9	22	12	24	s. 43 w.	18	Tacoma, Wash.	19	23	13	9	s. 45 e.	6
Pittsburg, Pa.	18	19	12	27	s. 86 w.	15	Tatoosh Island, Wash.	8	11	36	9	s. 84 e.	27
Parkersburg, W. Va.	15	22	10	17	s. 45 w.	10	Astoria, Oreg.	17	12	15	26	n. 66 w.	12
Elkins, W. Va.	13	15	7	29	s. 85 w.	22	Portland, Oreg.	22	10	15	24	n. 37 w.	15
<i>Lower Lake Region.</i>							Roseburg, Oreg.	22	10	15	24	n. 37 w.	15
Buffalo, N. Y.	8	21	9	32	s. 61 w.	26	<i>Middle Pacific Coast Region.</i>						
Oswego, N. Y.	14	21	10	23	s. 62 w.	15	Eureka, Cal.	20	18	17	12	n. 68 e.	5
Rochester, N. Y.	6	22	7	32	s. 57 w.	30	Mount Tamalpais, Cal.	26	9	17	13	n. 3 w.	17
Syracuse, N. Y.	10	21	7	26	s. 60 w.	22	Red Bluff, Cal.	37	11	9	5	n. 9 e.	26
Eric, Pa.	8	20	7	33	s. 65 w.	29	Sacramento, Cal.	32	9	14	14	n.	23
Cleveland, Ohio	12	28	13	18	s. 17 w.	17	San Francisco, Cal.	30	6	8	24	n. 34 w.	29
Sandusky, Ohio†	4	12	4	12	s. 45 w.	11	Point Reyes Light, Cal.*	13	5	3	14	n. 54 w.	14
Toledo, Ohio	12	21	6	27	s. 67 w.	23	<i>Southern Pacific Coast Region.</i>						
Detroit, Mich.	13	18	7	30	s. 78 w.	24	Fresno, Cal.	26	10	6	24	n. 48 w.	24
<i>Upper Lake Region.</i>							Los Angeles, Cal.	20	11	20	20	n.	9
Alpena, Mich.	16	13	5	34	n. 84 w.	29	San Diego, Cal.	21	7	21	20	n. 4 e.	14
Escanaba, Mich.	22	14	4	29	n. 72 w.	26	San Luis Obispo, Cal.	25	9	2	19	n. 47 w.	23
Grand Haven, Mich.	17	19	12	21	s. 77 w.	9	<i>West Indies.</i>						
Houghton, Mich.†	12	2	7	12	n. 27 w.	11	Basseterre, St. Kitts, W. I.	6	1	52	0	n. 86 e.	52
Marquette, Mich.	18	12	4	34	n. 79 w.	31	Bridgetown, Barbados	0	6	26	0	s. 77 e.	27
Port Huron, Mich.	13	15	7	33	s. 86 w.	26	Grand Turk, W. I.†	0	13	8	28	n. 68 w.	22
Sault Ste. Marie, Mich.	15	13	16	23	w.	7	Hamilton, Bermuda	21	13	8	28	n. 67 e.	22
Chicago, Ill.	15	13	7	30	w.	23	Havana, Cuba†	4	5	23	1	s. 87 e.	22
Milwaukee, Wis.	15	12	5	34	n. 84 w.	29	Puerto Principe, Cuba	1	21	43	1	s. 65 e.	46
Green Bay, Wis.	16	23	6	25	s. 70 w.	20	San Juan, Porto Rico	1	21	43	1	s. 65 e.	46
Duluth, Minn.	18	17	8	32	n. 88 w.	24							

* From observations at 8 p. m. only. † From observations at 8 a. m. only.

TABLE IV.—Thunderstorms and auroras, February, 1903.

States.	No. of stations.																																		Total.	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	No.	Days.		
Alabama	82	T.	1	1	1			2			1	1		1	2		6									2	11	4				33	12	T.		
Arizona	56	A.					1										1									2						0	0	A.		
Arkansas	57	T.	2	9	15			2			1			3	6	3										3	2					46	10	T.		
California	167	A.	1	1				3															5									10	0	A.		
Colorado	81	T.	1							1			1	1					1													0	1	T.		
Connecticut	21	A.			9	1																					1					11	0	A.		
Delaware	5	T.			3																											0	0	T.		
Dist. of Columbia	4	A.																														0	0	A.		
Florida	47	T.	2		2			1			2	4		2	2		1					1		1		2	5	1				26	0	T.		
Georgia	55	A.						1			1	11				1	11	1				2				1	5	18				52	10	A.		
Idaho	34	T.																														0	0	T.		
Illinois	92	A.		3													1															0	0	A.		
Indiana	58	T.	1	1										1																		0	1	T.		
Indian Territory	11	A.		1																												0	0	A.		
Iowa	149	T.	1	2																												0	0	T.		
Kansas	77	A.	4	30				1																								35	3	A.		
Kentucky	41	T.	1	1		1									2												4	1				10	0	T.		
Louisiana	46	A.	2	4	3		1	2	4		1	12	2	1	5	4	2	9	2	1					1	2	8	6	2			74	21	A.		
Maine	19	T.			4																											0	0	T.		
Maryland	48	A.			20														1										3			24	3	A.		
Massachusetts	48	T.			10																			1								10	1	T.		
Michigan	106	A.	2																													0	0	A.		
Minnesota	67	T.																														0	0	T.		
Mississippi	44	A.	4	8	8	3		1	10		3			5	2	1	8									7	8	2				70	14	A.		
Missouri	95	T.	20	34										1	1	1										1						58	6	T.		
Montana	40	A.																														0	0	A.		
Nebraska	142	T.	1	1												1					2											3	2	T.		
Nevada	40	A.																														0	0	A.		
New Hampshire	19	T.	1		9																						1	1				12	4	T.		
New Jersey	51	A.			20																											20	1	A.		
New Mexico	31	T.																														0	0	T.		
New York	99	A.	11	1	2	1		1					1																			17	6	A.		
North Carolina	56	T.															8	1										1	4			14	4	T.		
North Dakota	48	A.												1																		0	0	A.		
Ohio	128	T.	1	19	2				2	1						1							1	1								26	6	T.		
Oklahoma	23	A.		1	14																											15	2	A.		
Oregon	74	T.																														0	0	T.		
Pennsylvania	91	A.	1	4		8			1																				1			15	0	A.		
Rhode Island	7	T.																														0	0	T.		
South Carolina	46	A.		1								3				12	2										4	13				35	0	A.		
South Dakota	56	T.																														0	0	T.		
Tennessee	56	A.	1	2	7	3	2		1						2	7	1										13	7				7	4	A.		
Texas	95	T.	7	5		1		2	1	2	20		1	1	2	12	9			1					2	13	16	1			96	17	T.			
Utah	47	A.																														0	0	A.		
Vermont	16	T.	1		1																											2	0	T.		
Virginia	50	A.			2									1			2	1										1				6	4	A.		
Washington	64	T.	1																													1	1	T.		
West Virginia	43	A.			3			2																				1	1			7	4	A.		
Wisconsin	60	T.	1	3							1																					4	0	T.		
Wyoming	31	A.												1																		1	0	A.		
Sums	2,893	T.	15	110	129	100	4	4	29	3	5	42	21	3	20	28	21	67	7	2	1	0	3	5	1	3	15	42	63	59		802		T.		
		A.	1	2	0	0	2	0	0	0	1	0	0	1	3	2	1	2	0	1	0	2	1	1	1	0	0	0	0	0		21		A.		

Stations.	Date.	Total duration.		Total amount of precipita- tion.	Excessive rate.		Amount before excessive be- gan.	Depths of precipitation (in inches) during periods of time indicated.											
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.
Albany, N. Y.	1			0.44													*		
Alpena, Mich.	3-4			0.95													*		
Asheville, N. C.	3-4			1.36													0.61		
Atlanta, Ga.	16			2.20													0.48		
Atlantic City, N. J.	15-16			2.60													0.52		
Augusta, Ga.	16	4:30 p. m.	9:45 p. m.	0.59	6:00 p. m.	6:07 p. m.	0.02	0.37	0.46	0.48	0.49								
Do	28	7:08 a. m.	8:50 a. m.	0.61	7:17 a. m.	7:35 a. m.	0.03	0.15	0.28	0.43	0.49	0.51							
Baltimore, Md.	27-28			1.14													0.37		
Binghamton, N. Y.	16-17			0.64													*		
Bismarck, N. Dak.	22			0.04													*		
Block Island, R. I.	16-17			1.53													*		
Boise, Idaho.	10			0.28													0.17		
Boston, Mass.	4			0.51													0.32		
Buffalo, N. Y.	11			0.32													0.48		
Cairo, Ill.	3			1.00													0.41		
Charleston, S. C.	11			0.57													0.50		
Charlotte, N. C.	16			1.13													*		
Chattanooga, Tenn.	27-28			2.69													*		
Chicago, Ill.	3-4			1.33													0.57		
Cincinnati, Ohio.	3-4			1.57													0.57		
Cleveland, Ohio.	27-28			1.27													0.16		
Columbia, Mo.	2-3			1.78													*		
Columbia, S. C.	16			0.96													0.65		
Columbus, Ohio.	3-4			1.13													0.22		
Corpus Christi, Tex.	26	6:18 a. m.	7:40 a. m.	0.85	6:22 a. m.	6:55 a. m.	T.	0.25	0.39	0.53	0.58	0.68	0.75	0.79	0.82		*		
Davenport, Iowa.	3-4			1.04													*		
Denver, Colo.	11-13			0.23													*		
Des Moines, Iowa.	3-4			0.75													*		
Detroit, Mich.	27-28			1.10													0.22		
Dodge, Kans.	24-26			2.15													*		
Dubuque, Iowa.	26-27			0.50													0.15		
Duluth, Minn.	27-28			0.20													*		
Eastport, Me.	11-12			0.57													0.17		
Elkins, W. Va.	27-28			1.00													0.41		
Erie, Pa.	15-17			1.56													*		
Escanaba, Mich.	27			0.28															

TABLE V.—Accumulated amounts of precipitation for each 5 minutes, etc.—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (In inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6	7														
Savannah, Ga.	27			1.79														0.68			
Scranton, Pa.	28			1.13														0.27			
Seattle, Wash.	8-9			0.77														0.11			
Shreveport, La.	6-7			1.70														0.40			
Spokane, Wash.	7-8			0.20														*			
Springfield, Ill.	3-4			1.26														*			
Springfield, Mo.	14-15			1.37														*			
Tampa, Fla.	20-21			3.26														0.38			
Taylor, Tex.	9-10	5:05 p. m.	8:50 a. m.	1.15	4:57 a. m.	5:10 a. m.	0.17	0.11	0.45	0.54	0.56	0.57						0.20			
Toledo, Ohio.	27-28			1.10														*			
Topeka, Kan.	26			0.48														*			
Valentine, Nebr.	26-27			0.50														*			
Vicksburg, Miss.	6-7			3.73														0.54			
Washington, D. C.	28	8:50 a. m.	10:40 a. m.	0.53	9:45 a. m.	9:58 a. m.	0.05	0.34	0.45	0.48								0.19			
Wilmington, N. C.	7-8			1.68														*			
Yankton, S. Dak.	3-4			1.88														*			
Bridgetown, Barbados	27			0.13							0.13										
Havana, Cuba	23	D. N.	4:36 p. m.	2.67	12:35 p. m.	1:25 p. m.	0.84	0.11	0.26	0.34	0.43	0.57	0.78	1.02	1.23	1.41	1.56	1.63	1.73		
Puerto Principe, Cuba																					
San Juan, Porto Rico	18			0.27														0.21			

* Self-register not working.

† February 24.

‡ February 26.

TABLE VI.—Data furnished by the Canadian Meteorological Service, February, 1903.

Stations.	Pressure, in inches.			Temperature.				Precipitation.			Stations.	Pressure, in inches.			Temperature.				Precipitation.		
	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean.	Departure from normal.	Mean maximum.	Mean minimum.	Total.	Departure from normal.	Depth of snow.		Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean.	Departure from normal.	Mean maximum.	Mean minimum.	Total.	Departure from normal.	Depth of snow.
<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	°	°	°	°	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	°	°	°	°	<i>Ins.</i>	<i>Ins.</i>	<i>Ins.</i>	
St. John's, N. F.	29.42	29.56	-0.27	21.5	-0.5	28.3	14.6	2.67	-2.24	22.1	Parry Sound, Ont.	29.25	29.98	-0.03	18.1	+3.8	27.7	-8.6	3.87	+0.95	22.1
Sydney, C. B. I.	29.72	29.76	-0.16	20.0	+0.7	27.6	12.3	4.05	-0.04	24.5	Port Arthur, Ont.	29.32	30.06	-0.01	7.9	+1.5	20.0	-4.3	0.29	-0.61	2.9
Halifax, N. S.	29.73	29.84	-0.11	25.1	+2.7	32.4	17.8	3.71	-1.45	16.9	Winnipeg, Man.	29.25	30.14	-0.04	2.9	+4.5	14.5	-8.6	0.10	-0.88	1.0
Grand Manan, N. B.	29.80	29.85	-0.13	25.7	+2.3	32.3	19.1	4.17	+0.20	9.0	Minnedosa, Man.	28.21	30.15	-0.06	0.9	+3.6	12.0	-10.2	0.29	-0.32	2.9
Yarmouth, N. S.	29.81	29.88	-0.11	28.4	+2.6	34.0	22.8	2.80	-1.94	10.6	Qu'Appelle, Assin.	27.72	30.10	-0.02	4.5	+5.1	14.1	-5.1	0.12	-0.61	1.2
Charlottetown, P. E. I.	29.76	29.80	-0.15	17.8	+0.2	25.6	10.0	2.39	-0.67	17.7	Medicine Hat, Assin.	27.75	30.14	-0.09	16.7	+5.5	28.1	-5.2	0.30	-0.37	3.0
Chatham, N. B.	29.76	29.79	-0.17	14.4	+1.9	26.0	2.7	4.22	+1.06	33.7	Swift Current, Assin.	27.45	30.18	-0.11	10.5	+2.5	20.1	-0.8	0.56	-0.18	5.6
Father Point, Que.	29.85	29.88	-0.10	14.0	+2.5	21.5	6.5	5.34	-3.13	38.8	Calgary, Alberta	26.37	30.04	-0.05	21.6	+8.1	32.5	-10.9	0.50	-0.13	5.0
Quebec, Que.	29.57	29.91	-0.08	14.6	+2.8	21.5	7.6	5.86	-2.59	39.2	Banff, Alberta	25.33	30.15	-0.17	15.8	+3.4	27.6	-3.9	0.48	-0.44	4.8
Montreal, Que.	29.74	29.96	-0.06	18.7	+4.2	25.7	11.6	5.28	-2.21	26.5	Edmonton, Alberta	27.64	30.02	-0.00	17.6	+9.3	29.8	-5.3	0.26	-0.41	2.6
Bissett, Ont.	29.37	30.01	-0.00	10.2	+0.3	23.5	-3.1	3.44	+1.44	24.4	Prince Albert, Sask.	28.41	30.06	-0.05	3.8	+6.8	16.4	-8.8	0.21	-0.48	2.1
Ottawa, Ont.	29.69	30.03	-0.01	18.2	+6.5	26.0	10.4	4.25	-1.56	26.5	Battleford, Sask.	28.29	30.14	-0.05	5.4	+5.3	17.0	-6.1	0.04	-0.33	0.4
Kingston, Ont.	29.67	30.00	-0.04	23.1	+5.3	30.3	16.0	2.50	-0.04	14.5	Kamloops, B. C.	28.92	30.18	-0.22	26.3	+2.0	33.7	-19.0	0.02	-0.77	0.0
Toronto, Ont.	29.62	30.02	-0.02	25.7	+4.2	32.1	19.4	2.80	-0.19	13.0	Victoria, B. C.	30.10	30.20	-0.20	39.8	+0.3	44.6	-35.0	1.31	-2.79	1.4
White River, Ont.	28.69	30.09	+0.07	0.6	+0.4	18.7	-17.6	0.98	-0.54	9.8	Barkerville, B. C.	25.69	30.12	-0.21	21.1	+2.2	30.1	-12.1	0.46	-2.60	4.0
Port Stanley, Ont.	29.38	30.05	-0.01	24.7	+1.9	31.2	18.1	3.43	-0.22	11.4	Hamilton, Bermuda.	30.03	30.20	-0.09	64.0	+2.5	70.0	-58.1	1.44	-3.00	0.0
Saugeen, Ont.	29.28	30.01	-0.01	23.5	+3.6	30.8	16.3	2.74	-0.16	22.5	Dawson City, Yukon	28.77	30.20	-0.00	-9.2	.....	-0.6	-17.8	1.35	.....	13.5

TABLE VII.—Heights of rivers referred to zeros of gages, February, 1903.

Stations.	Distance to mouth of river.	Danger line on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.	Stations.	Distance to mouth of river.	Danger line on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.						Height.	Date.	Height.	Date.		
<i>Mississippi River.</i>									<i>Missouri River—Cont'd.</i>								
St. Paul, Minn. ¹	1,954	14							St. Joseph, Mo.	481	10	2.2	28	0.7	1	1.3	1.5
Red Wing, Minn. ¹	1,914	14							Kansas City, Mo.	388	21	12.7	23	5.6	5	7.0	7.1
Reeds Landing, Minn.	1,884	12	0.8	19	0.0	24-25	0.3	0.8	Glasgow, Mo.	231		6.5	25	0.4	20, 21	2.4	6.1
La Crosse, Wis. ¹	1,819	12							Boonville, Mo.	199	20	15.8	25	6.8	9	8.9	9.0
Prairie du Chien, Wis. ¹	1,759	18							Hermann, Mo.	103	24	12.6	4	5.0	21-23	8.1	7.6
Dubuque, Iowa. ¹	1,690	15							<i>Illinois River.</i>								
Leclaire, Iowa. ¹	1,609	10							Peoria, Ill.	135	14	16.4	19, 20	12.8	1	14.8	3.6
Davenport, Iowa. ¹	1,593	15							<i>Youghiogheny River.</i>								
Muscatine, Iowa.	1,562	16	5.9	17	3.8	26	4.7	2.1	Confluence, Pa.	59	10	7.2	16	2.6	24-27	3.8	4.6
Galland, Iowa.	1,472	8	2.8		1.8	9	1.7	1.8	West Newton, Pa. ³	15	23	16.9	28	2.9	11	6.3	14.0
Keokuk, Iowa.	1,463	15	6.8	21, 22	1.8	9	3.4	5.0	<i>Allegheny River.</i>								
Hannibal, Mo. ¹	1,402	13	8.9	18	4.2	13	5.2	4.7	Warren, Pa. ²	177	14	10.1	5	2.8	18	5.5	7.3
Grafton, Ill.	1,306	23	10.2	28	6.9	20	8.1	3.3	Oil City, Pa.	123	13	12.8	5	3.0	27	5.5	9.8
St. Louis, Mo.	1,264	30	16.0	6	7.6	21	10.7	8.4	Parker, Pa. ³	73	20	12.2	5	3.2	19	7.4	9.0
Chester, Ill.	1,189	30	13.1	7	7.0	22, 23	9.2	6.1	Freeport, Pa.	29	20	23.5	5	3.8	23, 24	10.1	19.7
New Madrid, Mo.	1,003	34	34.9	28	17.5	1	30.3	17.4	<i>Clarion River.</i>								
Memphis, Tenn.	843	33	33.9	28	10.8	1	26.5	23.1	Clarion, Pa.	32	10	11.0	5	2.6	19	5.8	8.4
Helena, Ark.	767	42	43.7	28	16.9	1	34.0	26.8	<i>Monongahela River.</i>								
Arkansas City, Ark.	635	42	45.8	28	20.8	2	35.3	25.0	Weston, W. Va. ⁴	161	18	14.0	28	3.8	1	5.3	10.2
Greenville, Miss.	595	42	40.0	28	16.6	2, 3	29.6	23.4	Fairmont, W. Va.	119	25	23.8	28	2.4	11	6.6	21.4
Vicksburg, Miss.	474	45	44.2	28	21.0	4	33.0	23.2	Greensboro, Pa.	81	18	26.0	28	8.3	23-25	11.2	17.7
New Orleans, La.	108	16	16.5	27, 28	9.1	8	12.7	7.4	Lock No. 4, Pa.	40	28	30.1	16	8.9	11, 12	13.1	21.2
<i>James River.</i>									<i>Conemaugh River.</i>								
Huron, S. Dak. ¹	210	9							Johnstown, Pa.	64	7	11.5	28	3.0	22, 23, 26, 27	4.3	8.5
<i>Missouri River.</i>									<i>Red Bank Creek.</i>								
Bismarck, N. Dak.	1,309	14	4.2	1	3.4	28	3.8	0.8	Brookville, Pa.	35	8	5.2	4	1.2	10, 11	2.1	4.0
Pierre, S. Dak. ¹	1,114	14							<i>Beaver River.</i>								
Sioux City, Iowa ¹	784	19							Ellwood Junction, Pa. ⁵	16	14	8.7	28	3.0	9-16, 18	4.7	5.7
Omaha, Nebr. ¹	669	18															

TABLE VII.—*Heights of rivers referred to zeros of gages*—Continued.

(1) Frozen. (2) Frozen for 9 days. (3) Frozen for 8 days. (4) Frozen for 7 days. (5) Frozen for 10 days. (6) Frozen for 11 days. (7) Frozen for 5 days. (8) Record incomplete.

CLIMATOLOGY OF COSTA RICA.

Communicated by H. PITTIER, Director, Physico-Geographic Institute.

TABLE 1.—Hourly observations at the Observatory, San José de Costa Rica, during February, 1903.

Hours.	Pressure.		Temperature.		Relative humidity.		Rainfall.		
	Observed, 1903.	Normal, 1889-1900.	Observed, 1903.	Normal, 1889-1900.	Observed, 1903.	Normal, 1889-1900.	Observed, 1903.	Normal, 1889-1900.	Duration, 1903.
	Inches.	Inches.	° F.	° F.	%	%	Ins.	Ins.	Hrs.
1 a. m.	26.18	26.15	63.3	61.6	80	83			
2 a. m.	26.16	26.13	63.0	61.2	80	84			
3 a. m.	26.15	26.12	62.6	60.7	80	84			
4 a. m.	26.14	26.11	62.3	60.4	80	84			
5 a. m.	26.13	26.12	62.2	60.1	79	84			
6 a. m.	26.14	26.13	62.1	59.9	79	84	.01	.01	0.50
7 a. m.	26.15	26.15	61.9	60.0	79	84			
8 a. m.	26.16	26.16	64.0	62.1	74	78			
9 a. m.	26.18	26.17	68.2	66.6	63	70			
10 a. m.	26.19	26.18	72.3	70.5	59	62			
11 a. m.	26.19	26.17	75.2	73.8	50	58			
Noon	26.17	26.16	78.1	75.7	46	56			
1 p. m.	26.15	26.14	79.7	77.2	50	54			
2 p. m.	26.13	26.11	79.2	77.3	44	53			
3 p. m.	26.11	26.10	78.8	76.6	49	55			
4 p. m.	26.10	26.08	75.5	74.7	57	58			
5 p. m.	26.10	26.09	72.4	71.8	61	63			
6 p. m.	26.11	26.10	69.4	68.9	70	70			
7 p. m.	26.13	26.11	67.3	65.9	76	76			
8 p. m.	26.15	26.14	66.0	64.6	78	79			
9 p. m.	26.16	26.15	65.5	64.0	75	80			
10 p. m.	26.18	26.16	65.1	63.1	79	82			
11 p. m.	26.19	26.17	64.6	62.6	79	83			
Midnight	26.19	26.16	64.0	62.1	79	83			
Mean	26.15	26.14	68.4	66.7	69	73			
Minimum	26.04	25.96	57.9	46.8	32				
Maximum	26.27	26.29	84.4	89.6	100				
Total							0.01	0.06	0.50

REMARKS.—At San José the barometer is 1,169 meters above sea level. Readings are corrected for gravity, temperature, and instrumental error. The hourly readings for pressure, and wet and dry bulb thermometers, are obtained by means of Richard registering instruments, checked by direct observations every three hours from 7 a. m. to 10 p. m. The thermometers are 1.5 meters above ground and are corrected for instrumental errors. The total hourly rainfall is as given by Hottinger's self-register, checked once a day. Under maximum, the greatest hourly rainfall for the month is given. The standard rain gage is 1.5 meters above ground. Since January 1, 1902, observations at San José have been made on seventy-fifth meridian time, which is 0 hours, 36 minutes, 13.3 seconds in advance of San José local time. The normals for pressure, temperature, and relative humidity have been adjusted to this time; the normal for rainfall in Table 1 and the sunshine observations and normal in Table 2 refer to local time. At Port Limón the hours of direct observation are 8 a. m., 2 and 8 p. m., San José local time; the barometer is 3.4 meters above sea level. The means for temperature and relative humidity in Table 4 are obtained from two-hourly readings given by a Richard self-registering thermometer.

TABLE 2.—San José, February, 1903—Continued.

Time.	Sunshine.		Cloudiness.		Temperature of the soil at depth of—				
	Observed, 1903.	Normal, 1889-1900.	Observed, 1903.	Normal, 1889-1900.	6 inches.	12 inches.	24 inches.	48 inches.	120 inches.
7 a. m.	8.70	10.35	39	32	73.6	74.2	74.4	71.6	70.7
8 a. m.	23.88	22.76							
9 a. m.	24.76	22.08							
10 a. m.	25.04	21.18	52	38	74.0	74.3	74.4	71.8	
11 a. m.	24.82	21.42							
Noon	24.96	21.21							
1 p. m.	24.19	21.29	49	44	75.5	74.8	74.4	71.8	
2 p. m.	25.73	21.82							
3 p. m.	24.01	21.45							
4 p. m.	22.61	19.12	58	53	76.4	75.4	74.5	71.7	
5 p. m.	13.24	14.56							
6 p. m.	2.34	4.27							
7 p. m.			63	54	76.2	75.5	74.5	71.0	
8 p. m.									
9 p. m.									
10 p. m.			50	43	75.5	75.3	74.5	71.6	
11 p. m.									
Midnight									
Mean			50	44	75.2	74.9	74.5	71.7	70.7
Total	244.28	221.51							

TABLE 3.—Rainfall at stations in Costa Rica, February, 1903.

Stations.	Height above sea level.	Observed, 1902.		Averages.	
		Amount.	Number of days.	Amount.	Number of days.
	Feet.	Inches.		Inches.	
Sipurio (Talamanca)	197	2.64	13		
Boca Banano	10	4.80	18		
Port Limón	10				
Swamp Mouth	10	7.60	18		
Zent	66				
Siquirres	197	9.53	7		
Dos Novillos	400				
Guapiles	984	5.79	16		
Cariblanco (Sarapiquí)	2,740	4.41	18		
San Carlos	528	2.56	17		
Las Lomas	873	0.47	10		
Peralta	1,089	3.70	13		
Turrialba	2,034				
Juan Vías	3,412	0.91	5		
Santiago	3,609	0.32	3		
Paraiso	4,383	0.12	1		
Cachi	3,346	1.85	9		
Las Concavas	4,386	0.28	5		
Tres Ríos	4,265				
San Isidro Arenilla					
San Francisco Guadalupe	3,894				
San José	3,806				
La Verbena	3,740	0.12	1		
Nuestro Amo	2,595	0.98	1		
Alajuela	3,117				
San Isidro Alajuela	4,416				

TABLE 4.—Observations taken at Port Limón and Zent, February, 1903.

Stations.	Pressure.			Temperature.			Relative humidity.
	Minimum.	Maximum.	Mean.	Minimum.	Maximum.	Mean.	
	Inches.	Inches.	Inches.	° F.	° F.	° F.	%
Port Limón	29.71	29.98	29.82	64.4	87.8	75.9	83
Zent				65.3	89.6	77.3	81

Stations.	Cloudiness.	Sunshine.	Rainfall.		Temperature of soil at depth of—		
			Amount.	Number of days.	6 inches.	12 inches.	24 inches.
	%	Hours.	Inches.		° F.	° F.	° F.
Port Limón			0.79	10			
Zent	77	121.90	6.73	22	77.0	77.7	77.5

MEXICAN CLIMATOLOGICAL DATA.

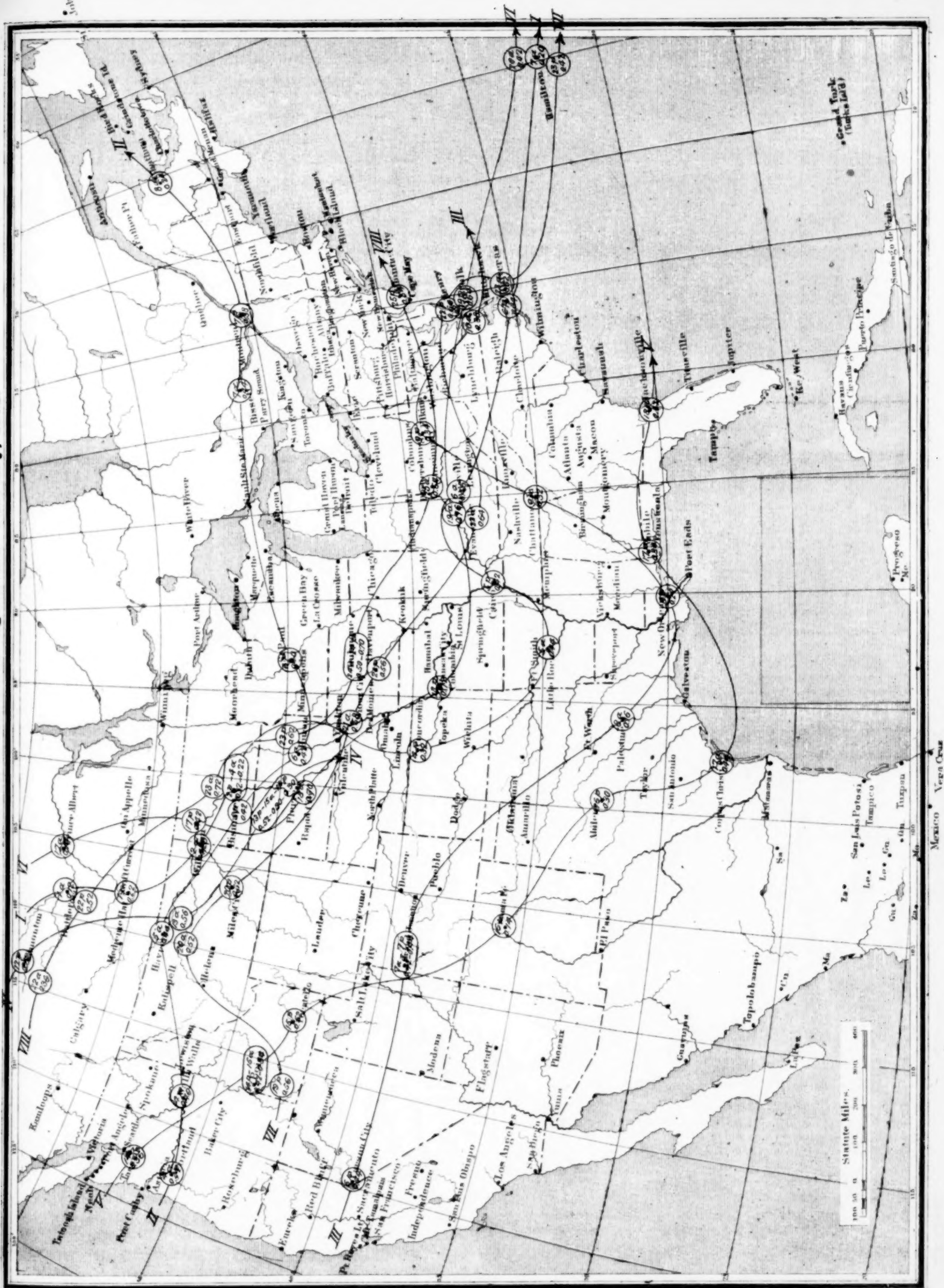
By Señor MANUEL E. PASTRANA, Director of the Central Meteorologic-Magnetic Observatory.

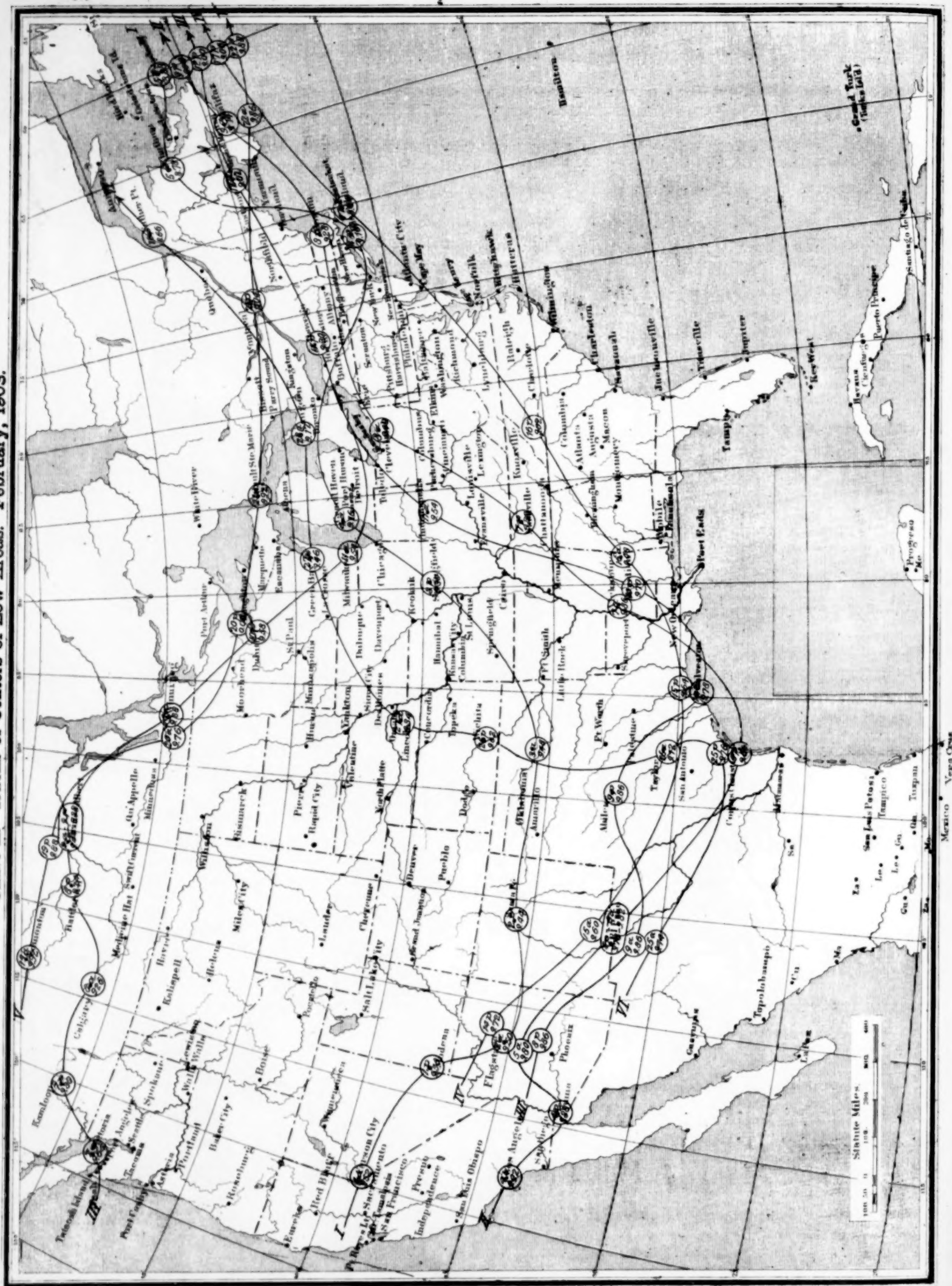
February, 1903.

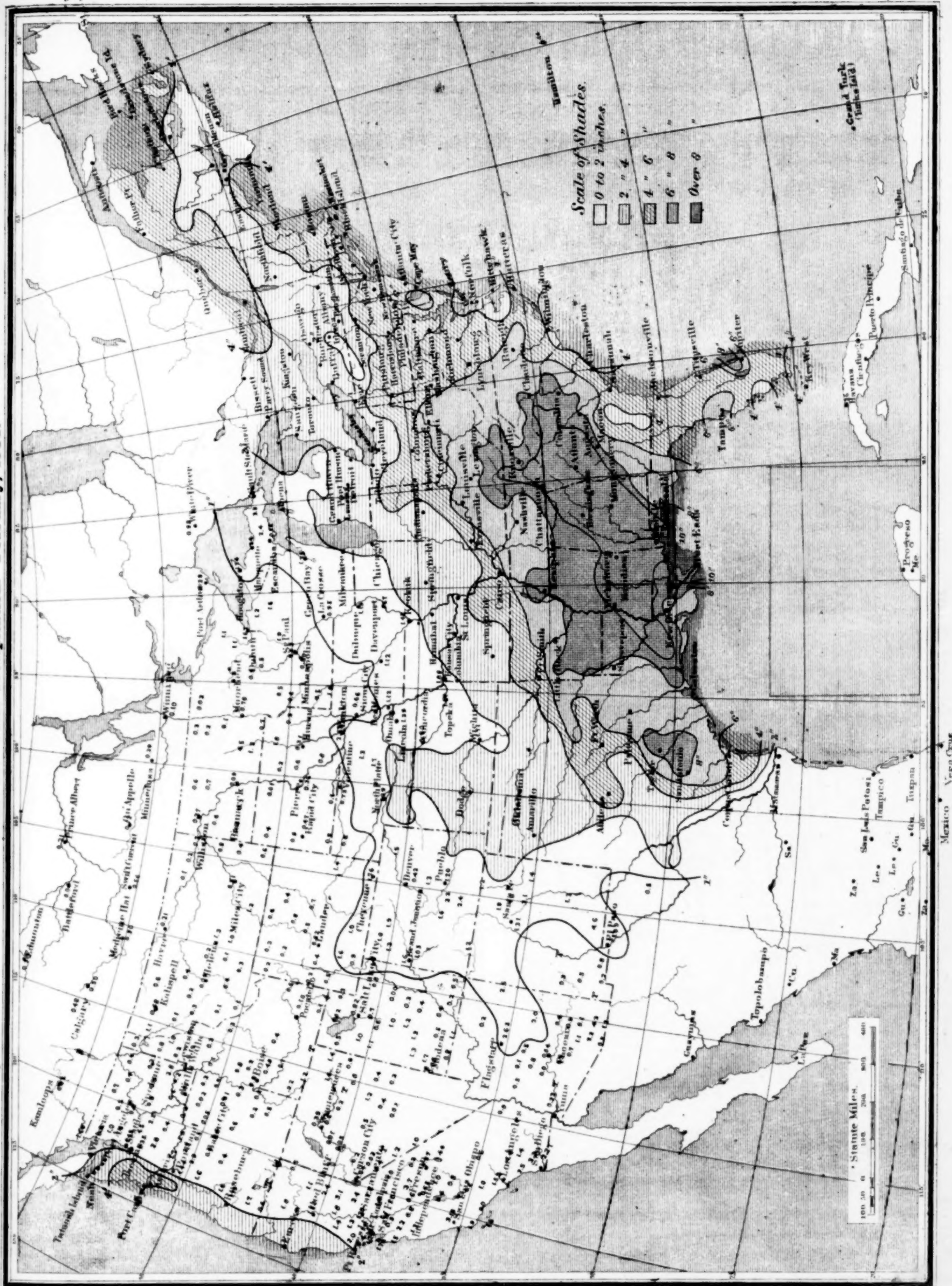
Stations.	Altitude.	Mean barometer.	Temperature.			Relative humidity.	Precipitation.	Prevailing direction.	
			Max.	Min.	Mean.			Wind.	Cloud.
	Feet.	Inches.	° F.	° F.	° F.	%	Ins.		
Chihuahua	4,684	25.18	73.4	29.8	53.8	34		sw.	
Guadalajara (Obs. del Est.)	5,186	24.91	82.4	43.7	62.6	54	0.37	se.	
Guajuato	6,640								
Leon (Guajuato)	5,906	24.24	79.3	38.5	59.4	58	0.03	nw.	
Mazatlan	25								
Merida	50	29.88	96.8	53.1	77.7	68	0.47	se.	
Mexico (Obs. Cent.)	7,472	23.01	77.0	39.2	59.4	49	0.82	e. sw.	sw.
Mexico (E. N. Agric.)	7,442								
Monterey (Seminario)	1,626	28.12	101.8	31.8	59.0	69	0.17	se.	
Morelia (Seminario)	6,401	23.90	75.2	40.3	58.1	61	0.03	s.	sw.
Puebla (Col. Cath.)	7,108	23.33	79.5	41.7	60.1	59	0.03	ene.	
Puebla (Col. d Est.)	7,118	23.30	78.1	38.7	57.4	58		ene.	
Queretario	6,070	24.10	77.9	41.9	60.3	50	0.11	w.	
Toluca	8,812								
Zacatecas	8,015	22.42	74.8	31.3	50.9	63		sw.	
Zapotlan	8,078	25.03	78.8	45.3	62.6	62	0.42	sse.	

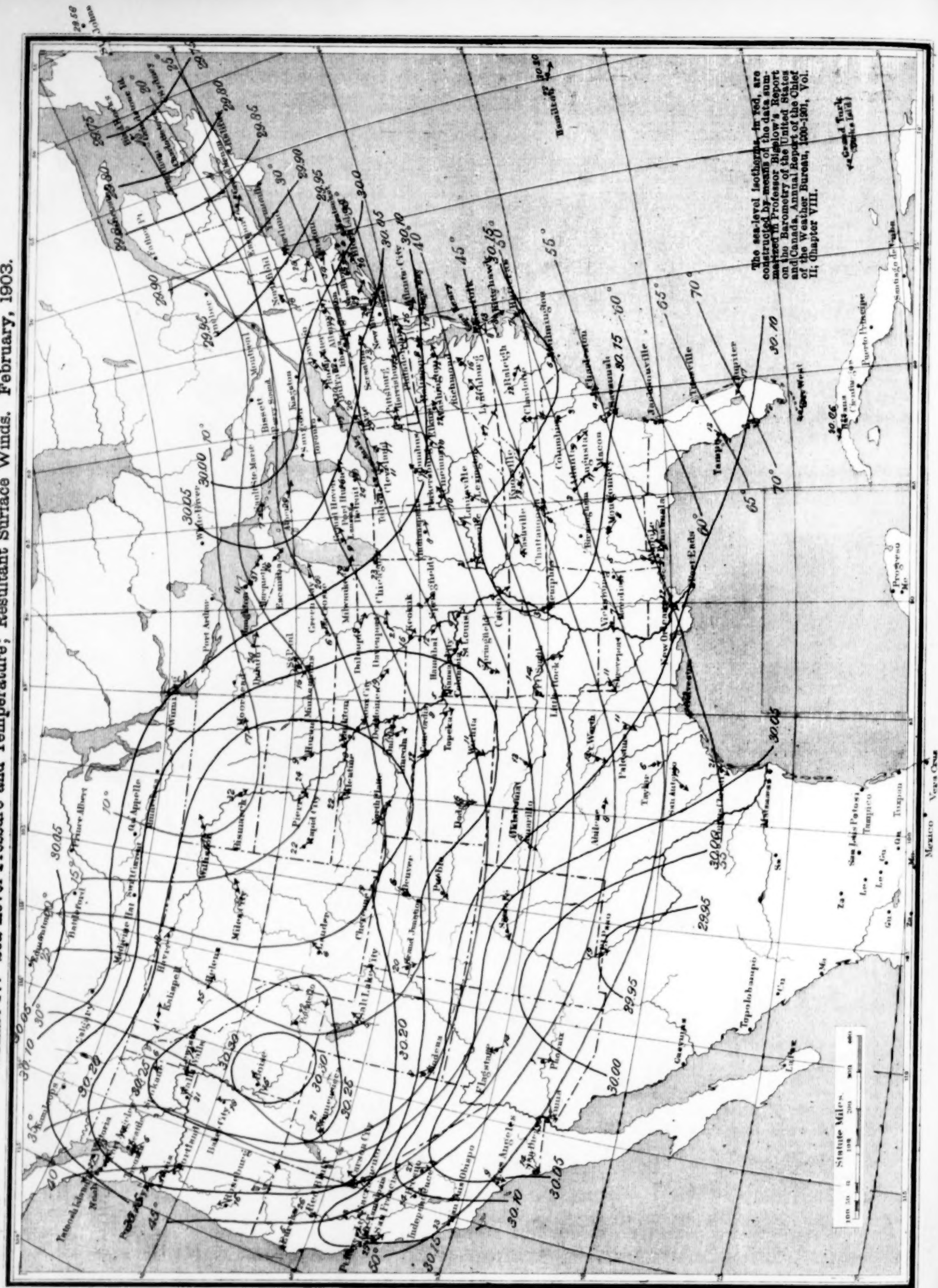
* The monthly barometric means are reduced to the international standard of gravity.

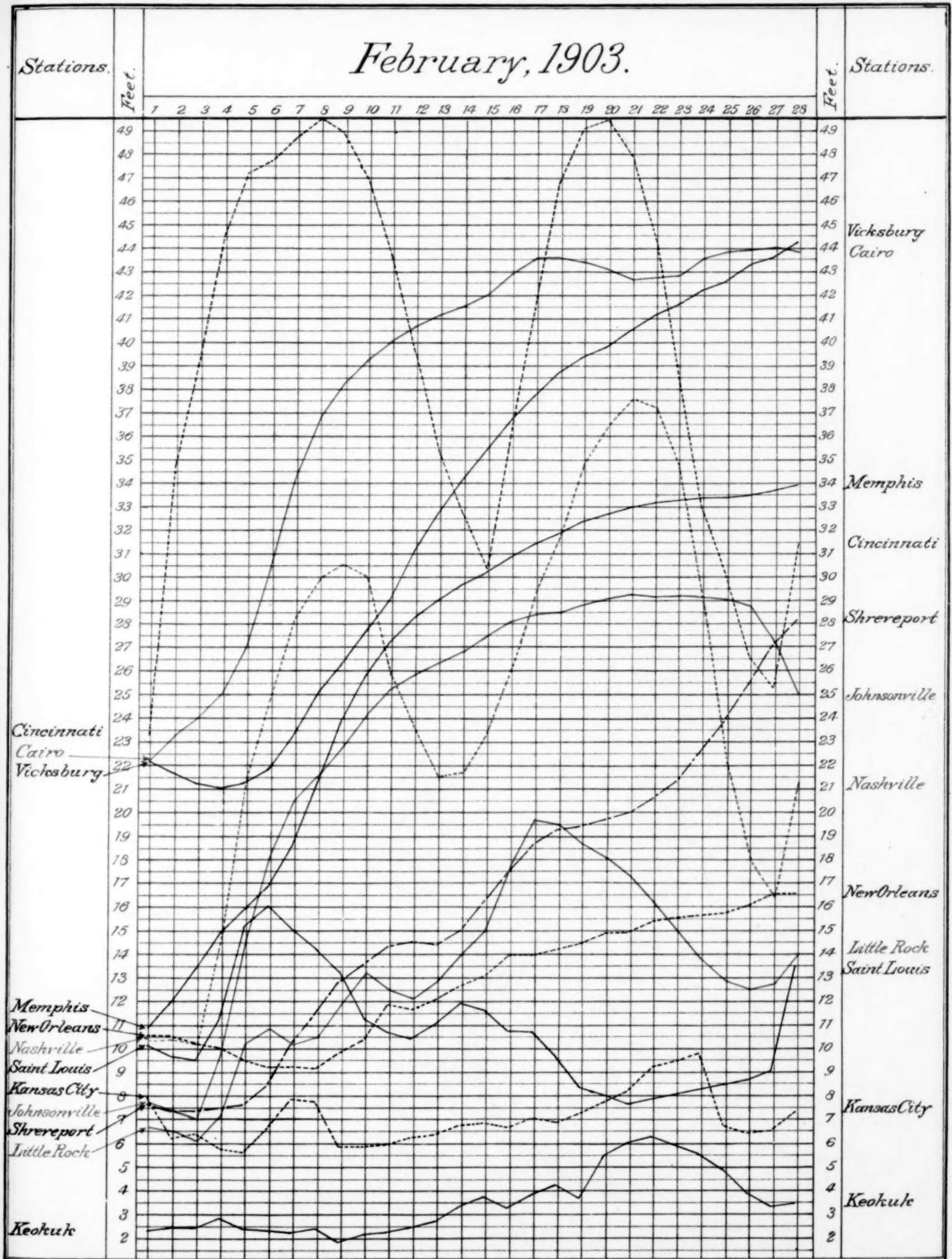
Chart I. Tracks of Centers of High Areas. February, 1903.











• Barkervill Chart VI. Surface Temperatures; Maximum, Minimum, and Mean. February, 1903.

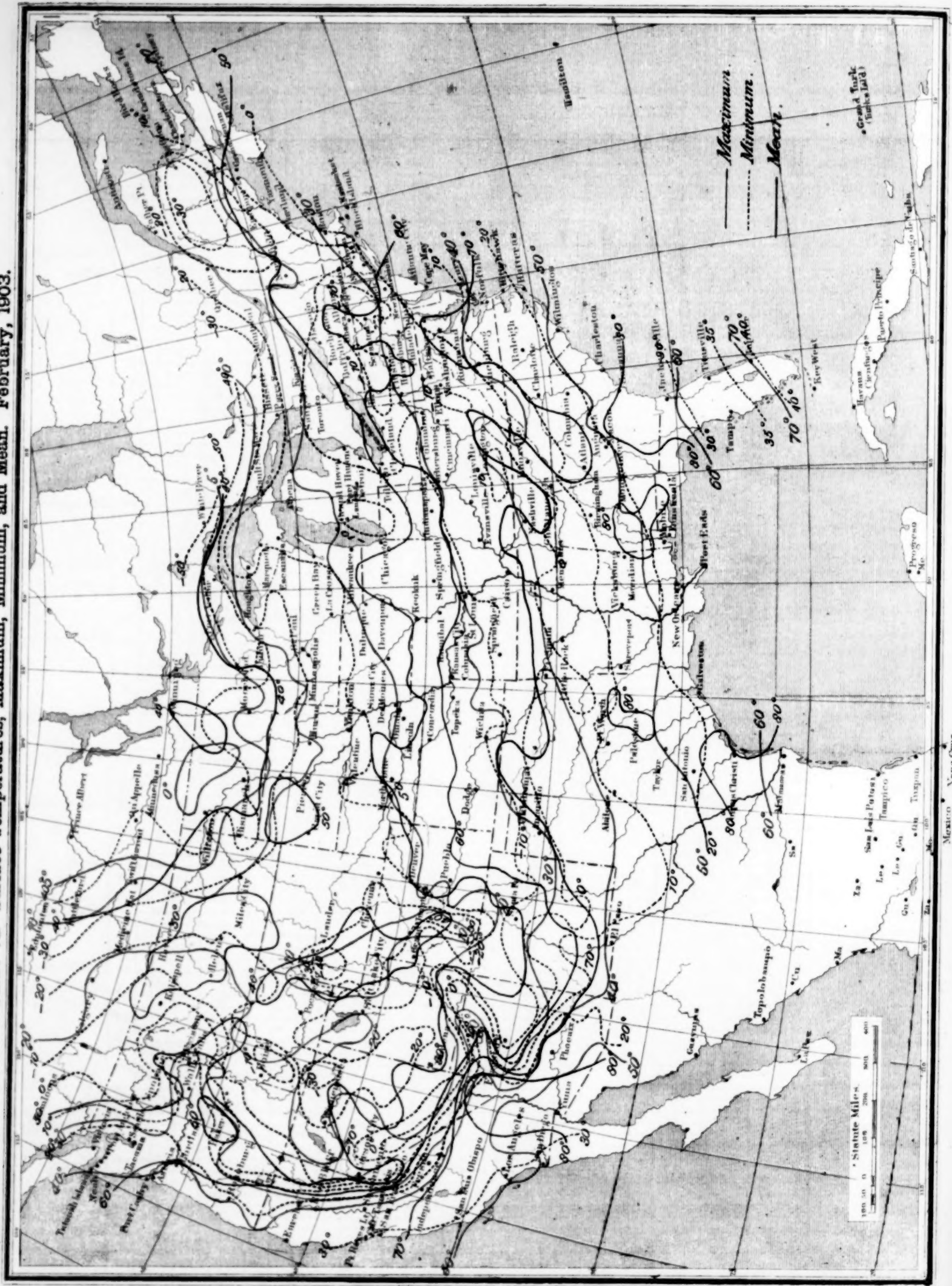
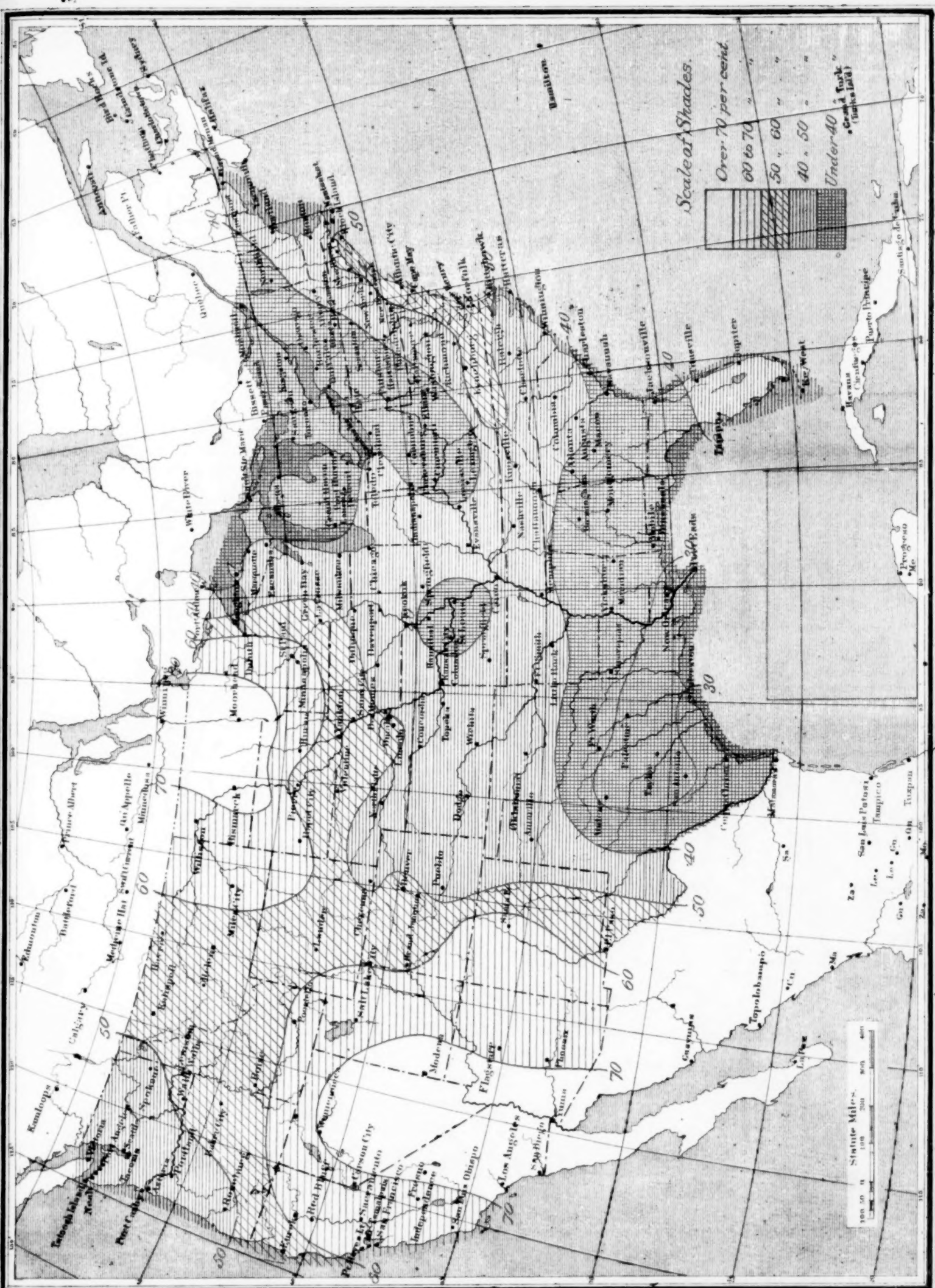


Chart VII. Percentage of Sunshine. February, 1903.



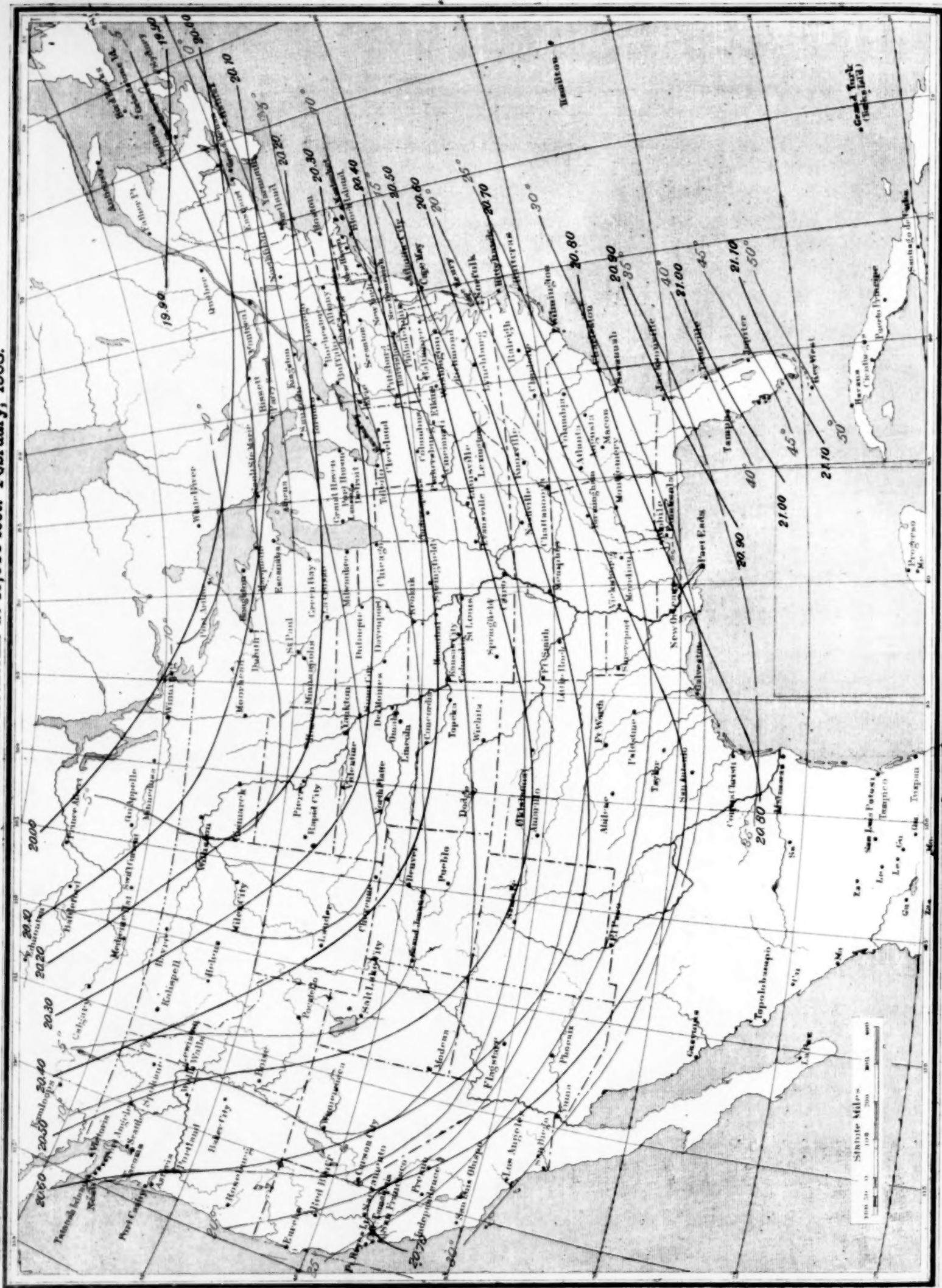


Chart IX. Isobars and Isotherms at 3,500 feet. February, 1903.

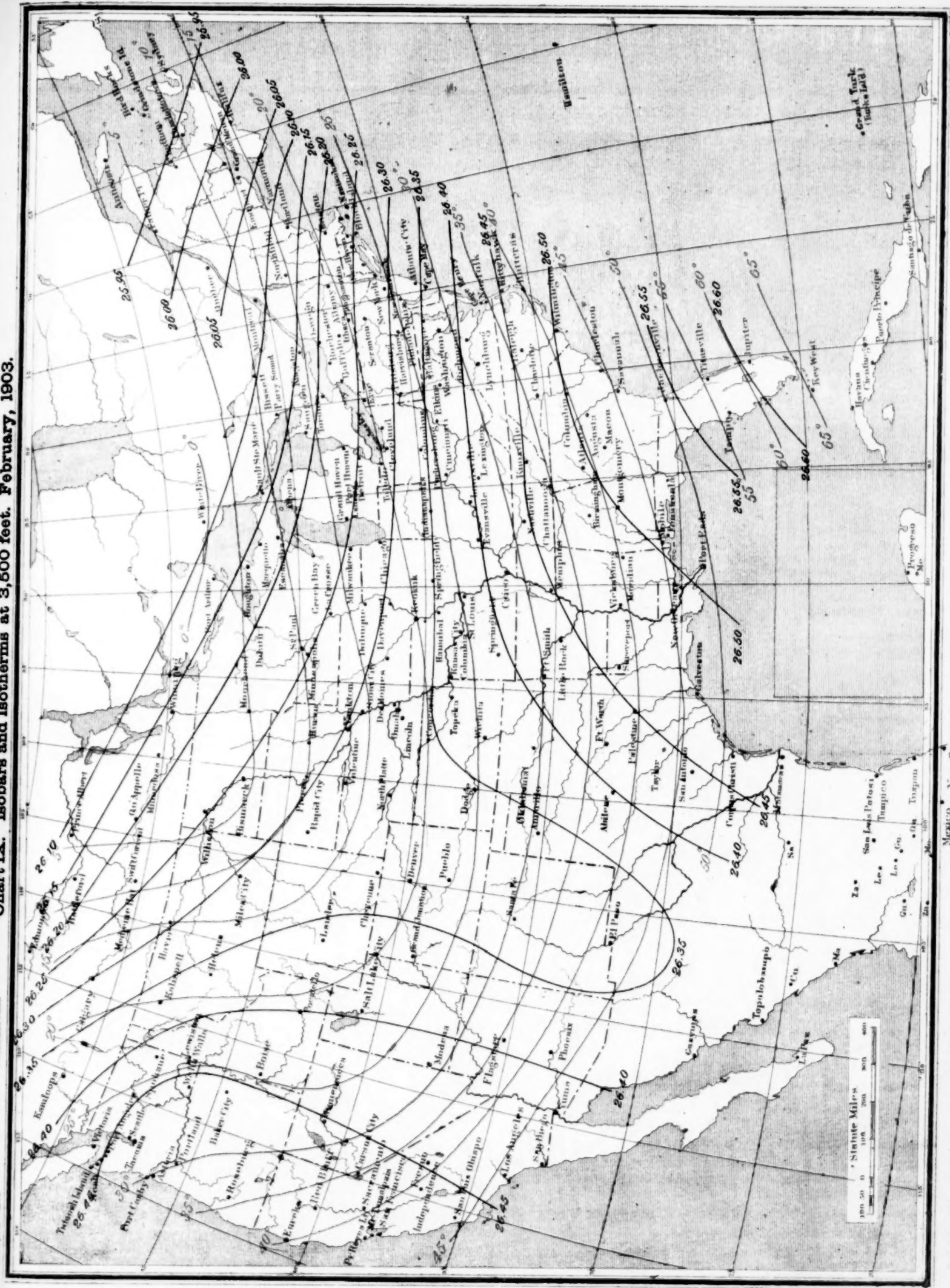


Chart X. Total Snowfall for February, 1903.

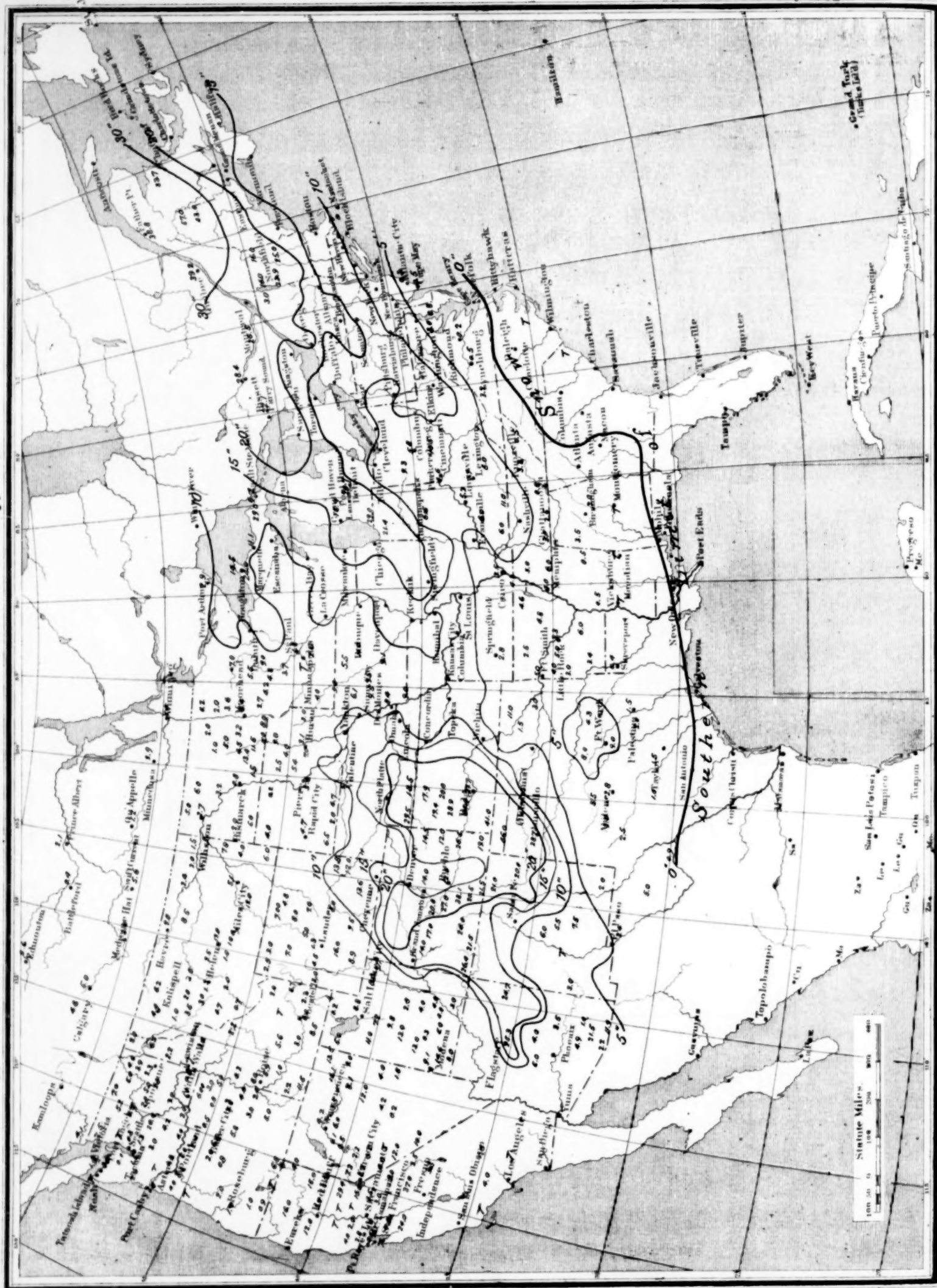


Chart XI. Depth of Snow on Ground on February 28, 1903.

